DIFFERENT ASPECTS OF PUNJABI PHONOLOGY

Thesis Submitted to the University of Delhi
for the Award of the Degree of

DOCTOR OF PHILOSOPHY

IN

LINGUISTICS

By

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CENTRE FOR ADVANCED STUDIES IN LINGUISTICS
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All the assistance received during the course of the study has been duly acknowledged.

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Mansi Bajaj

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LIST OF ABBREVIATIONS

σ	:	syllable
μ	:	mora
ˈ	:	accent
´	:	high tone
`	:	low tone
. and $	:	syllable boundary
˜	:	nasalized vowel
~	:	alternation
C	:	coda/ consonant
f0	:	fundamental frequency
N	:	nucleus/ nasal consonant
O	:	onset
R	:	rhyme
V	:	vowel
X	:	core skeleton
#	:	Word boundary
son	:	sonorant
con	:	consonantal
ret	:	retroflex
ant	:	anterior
cor	:	coronal
syll	:	syllabic
cont	:	continuant
spr glot	:	Spread glottis
wd	:	word

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ABSTRACT

Different Aspects of Punjabi Phonology

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Punjabi belongs to the group of Indo-Aryan languages and is spoken in many states of India and Pakistan. This thesis reviews the literature pertaining to the phonological problems in Punjabi language and then applies a syllable based non-linear generative approach to solving phonological problems in Punjabi language. The present work has studied various phonological problems, problems such as placement of accent, tones resulting from loss of aspiration, intonation, schwa deletion, nasal consonant formation and nasalization of vowels, glide insertion, alternation of high front glide /y/ with the back palatal voiced /j/, and occurrence of gemination. The present work takes the Prakrit forms as the underlying forms and posits nasal archisegment in the underlying form for solving the problem of nasal consonant assimilation. The present work also replaces the terms ‘high’ and ‘low’ tones with ‘rising’ and ‘falling’ tones as pitch tracings resolve the same. By doing so, the current work has made a three way bridge of bringing experimental phonology, theoretical phonology and phonological-morphological interface together in order to understand and explain the problems in phonology.

CHAPTER 1

INTRODUCTION

Punjabi is an Indo-Aryan language which is widely spoken in several states of the India and Pakistan. It is also one of the most common languages spoken in Canada, United Kingdom, United States of America, United Arab Emirates and across Europe. Punjabi consists of many dialects making it the 10th most widely spoken language in the world with more than 148 million speakers. Punjabi is divided into two principal languages: Western Punjabi (spoken majorly in Pakistan) and Eastern Punjabi (spoken mainly in India). Pothohari, Dhani, Shahpuri, Pahari, Multani etc are western dialects and Malwai, Majhi, Puadhi, Doabi, Dogri, etc are Eastern dialects.

This chapter is divided in four major sections. Linguistic features which make Punjabi distinct are discussed in the first section along with the linguistic features of its different dialects. The second section of the chapter surveys the different perspectives available on the theory of phonology and the insight gained from the review of work done on Punjabi is mentioned in brief in the third section of the chapter. The fourth section of the chapter outlines the major aims that motivate the present study. The chapter division and scheme of the present work is outlined in the last section of this chapter.

1.1. Punjabi Language and Dialects

The variety of Punjabi spoken differs minutely from one place to another though there are some characteristics of the language which sets it apart from other Indo-Aryan languages. These characteristics are listed by Grierson (1961, p. 615-617) in his grand survey *Linguistic Survey of India,* some of which are mentioned below:

1. The Prakrit dialects of India has a short vowel followed by a double consonant such as in [məkkʰəɳəm] ‘ointment/ butter’. This feature is retained in Punjabi, hence Punjabi has many words with a double consonants proceeded by a short vowel, eg. [məkkʰəɳ] ‘butter’, [kəmm] ‘work’, [ʊcca] ‘high/ tall’, etc.

2. Word initial voiced labiodental fricative [v] or labial approximant [w] are retained in many dialects of Punjabi as in [vicc] 'middle', [val] 'hair', etc. However these are replaced by voiced bilabial [b] in many dialects of Punjabi such as Malwai and Puadhi, it becomes [bɪcc], and [baɭ].
3. The genitive case marker in Punjabi is [-da] as in [ram-da kə̀r] 'Ram's house' as opposed to [-ka] or [-kəʊ] in Western Hindi.
4. Oblique plural case marker in Punjabi is [-ã] and the suffix to indicate case of agent is [-ne] as in [mʊɳɖeyã-ne].
5. The plurals of first and second person pronouns are very different [əsĩ] or [əsã] 'we' and [tʊsĩ] or [tʊsã] 'you'.
6. Word-final schwa present in Prakrit is deleted in Punjabi.

The features of Punjabi which make it a distinct language, as mentioned above, are common to both Eastern and Western Punjabi. Eastern Punjabi which is spoken largely in Indian Punjab and Western Punjabi, spoken majorly in Pakistan have some linguistic features which distinguish the two languages. Western Punjabi can also be perceived in the language used by particularly elderly members of the Indian community who had migrated to India at the time of Independence or post-Independence. Some of those features are discussed below:

1. The presence of tones wherever deaspiration takes place is peculiar to Eastern Punjabi language and makes it very distinct. In Western Punjabi, tones are observed on words with voiced aspirated sounds but there is no deaspiration.
2. Pronominal suffixes are joined to the verbs, such as [akʰea] 'said' + [ʊs] 'he' becomes [akʰɪos] 'he said'. This is a distinct feature of Western Punjabi and is not observed in Eastern Punjabi.
3. The plurals of first and second person pronouns are very different. [əsĩ] 'we' and [tʊsĩ] 'you' are used in Eastern Punjabi and [əsã] 'we' and [tʊsã] 'you' are used in Western Punjabi.
4. Lateral retroflex [ɭ] sound is used in most dialects of Eastern Punjabi.

This work is restricted to Punjabi as spoken in Indian Punjab, i.e. Eastern Punjabi. Eastern Punjabi has many dialects. Some of the linguistic differences of major varieties of Eastern Punjabi, as mentioned by Grierson (1961, p. 646, 671, 679, and 709) in his Linguistic Survey of India are discussed below:

1.1.1. Majhi

Majhi is used in the Majha region which covers region around Amritsar, Gurdaspur and a major part of Lahore region of Pakistan. The following features of the dialect make it distinct:

1. Lateral retroflex /ɭ/ is not present in Majhi at all, hence the words [naɭ] 'with' and [gəɭ] 'talk' are pronounced as [nal] and [gəl].

2. Doubling of voiced alveolar retroflex /ɖ/ is observed in Majhi as in [vəɖɖa] 'big/ great'.

3. Nasalization of vowels is frequent.

4. [ɖéya] is used in continuous tense in the place of [réya] as in *o kəmm kərən ɖeya si* 'He was doing work'. This form of the verb is used particularly in rural areas around Amritsar with some tone on it.

5. Use of auxiliary verb [ne] sometimes in place of present tense auxiliary [hən], eg. o kəmm kərde ne 'They do work'.

1.1.2. Doabi

Doabi is spoken in the Doab region of Punjab in India which lies between Satluj and Beas rivers. This region includes Hoshiarpur, Jalandhar, Nawanshahr and Kapurthala. The distinct features of the Doabi dialect are listed below.

1. /v/ in the word initial positions is replaced by /b/ in Doabi therefore words [bɪcc] 'middle', [bəɖɖa] 'big' are used in the place of [vɪcc] and [vəɖɖa]. Also, /v/ in word medial positions is replaced by /w/ as in [həwa] 'wind'.

2. Both alveolar lateral /l/ and retroflex lateral /ɭ/ are used alternatively eg. [nal] and [naɭ] 'with'.

3. Use of auxiliary verb [a] in place of [hən], eg. [o kəmm kərde a] 'They do work' and use of past tense auxiliary [sɪge] in place of [sən], eg. [o kəmm kərde sɪge] 'They used to work'.

1.1.3. Malwai

Malwai dialect of Punjabi is spoken in Malwa region of Punjab which lies in the south of river Satluj. Ferozpur, Faridkot, Malerkotla, Jind, Bhatinda, Patiala, Rupnagar, and Jalandhar districts of Punjab fall under Malwa region.

1. Lateral retroflex /ɭ/ and nasal retroflex /ɳ/ are used in Malwai but in the south Malwa, these are not much used. Hence in Ferozpur, speakers use [jana] 'to go' and [kol] 'nearby' in place of [jaɳa] and [koɭ].

2. Gemination is observed in Malwai as in [vɪcc] 'middle', [ɪkk] 'one'.

3. Word initially both voiced dental stop /d/ and labial voiced fricative /v/ are used in alternation as in [dek^{h}]~[vek^{h}] 'see'. [dida] is also used for verb 'see' in Malwai dialect. It is adopted from the Persian verb [didən] which means 'to see'.

4. Use of /-ũ/ in future tense verb endings (used for first person) makes Malwai distinct, eg. [aũga] 'will come', [piũga] 'will drink' in place of [aega] and [piega].

1.1.4. Puadhi

Puadhi is used in the Poadh region of Punjab including Chandigarh, Panchkula, Rajpura, Ropar, etc. The vocabulary used in Poadh region is little different from the other dialects of Punjabi mostly due to the influence of neighboring language. The distinct features of the dialect are discussed below:

1. Words such as [kehɳa] 'to say', [c^{h}okra] 'boy', [ɪb] 'now' etc are used. Some people also use [age] 'in front of' in place of [əgge] and [mhare] 'ours' in place of [saḍḍe].

2. Words like [vɪcc] 'middle' and [vəḍḍa] 'big' are spoken as [bɪcc] and [bəḍḍa].

3. Past tense auxiliary [t^ha] is used alternatively with [si]. [ta] and [ti] are used in areas between Poadh and Malwa regions.
4. [bati] 'sweets' and [gɛl] are some examples which are used only in Puadhi dialect of Punjabi.

In Eastern Punjabi, the standard dialect is moving towards Malwai due to larger geographical area occupied by the Malwa region (see Appendix II) in the Indian Punjab resulting in greater political representation and power acquired by its speakers. The present day Punjabi in India is dominated by linguistic elements of the Malwai dialect spoken in the Malwa region. The present work has taken spoken variety of this dialect of Punjabi in order to study its phonological aspects. Let us view the phonological theories before we analyze the phonological problems in Punjabi.

1.2. Literature Review of Phonological Theories

The terms 'morphophonology', 'morphophonemics', 'morphonology' etc have been used by scholars of different schools of thought to refer to the phonological problems arising at the phonology-morphology interface (discussed below). The present work will use the term 'interface' to refer to the phonology-morphology interface. Some structuralists suck as Trubetzkoy (1934/ 1971), Harris (1944), Pike (1947), etc have talked about the interface, however they did not use it to solve the phonological problems arising at the interface.

1.2.1. Structuralist Model

The **Structuralist model** aims at uncovering structures that underlie human language. It maintains that the elements of the language must be understood in their relationship to other structures and systems. Structuralism is often criticized for favoring deterministic structural forces over other things. It was descriptive, purely empirical and data-based. It aimed at finding out the language specific rules. This model takes phoneme to be the minimal unit and therefore it is not economical and has analytical problems. According to Sethi (1997), Courtenay (1895/ 1972) initially claimed that it is impossible to combine phonology and morphology, however later he realized that

some problems could be solved at the interface and made a distinction between phonologically and morphologically conditioned alternations. He made distinction between different alternations and developed a programme to study the interface, however, he did not investigate the different alternations systematically in depth (Sethi, 1997, p. 16-17). Saussure in *Course in General Linguistics* talked about syllable and its internal structure (Saussure, 1916/ 2011, p. 51- 58). He recognizes the importance of syllable in studying phonological problem and states "I do not pretend to resolve thereby all the difficulties brought about by dividing the spoken chain into syllables, but simply to provide a rational basis for studying the problem" (Saussure, 1916/ 2011, p. 52). He also emphasized the importance of phonetic relations in morphological make up of the word, however, he himself acknowledged that his theory "neither exhausts nor resolves all questions" (Saussure, 1916/ 2011, p. 59).

The terms morphonology and morphophonology were first used by scholars of **Prague school of linguistics**. Trubetzkoy (1934/ 1971) explains that the term morphophonolgy or morphonology refers to "the study of the utilization in morphology of the phonological means of language" (p. 305) and the term morphoneme was used for different phonological realizations of a morpheme. According to Trubetzkoy (1934/ 1971), morphophonological study has three parts: "(1) the study of the phonological structure of the morphemes; (2) the study of combinatory sound changes that take place in the morphemes in morpheme combinations; (3) the study of sound alternation series that fulfill a morphological function" (p. 306). Therefore morphonology for Prague School of Linguistics meant an interface of the disciplines of phonology and morphology to study the relation between sounds and their physical realizations in languages. This led to the development of 'distinctive features' which groups sound segments into natural classes. Jakobson and Halle (1956) define distinctive features as "… ultimate components capable of differentiating morphemes from each other" (p. 4). It looks at phoneme as a set of distinctive features thus its use leads one to reach explanatorily adequate generalizations. Trubetzkoy had proposed binary and multilateral oppositions (Trubetzkoy, 1934/ 1971, p. 90), however, this replaced with the binary oppositions of distinctive features, first by Jakobson, Fant and Halle (1951), Jakobson

and Halle (1956) in *Fundamentals of Language* as "reducing the phonemic information contained in the sequence to the smallest number of alternatives, we find the most economical and consequently the optimal solution" (Jakobson and Halle, 1956, p. 45). The scholars from Prague School of Linguistics hadn't developed a theory based on syllable to explain phonological problems.

The **American structuralists** used the term 'morphophonemics' to refer to the interface of phonology and morphology. Bloomfield (1933) studied significant sounds and tried to develop a system that could be used to describe any language synchronically. The structural organization of levels didn't allow for morphological analysis to be involved at phonological level. Harris (1951) argued that "… a major purpose in determining the phonemes is in order later to identify the morphemes, a phonetic arrangement which makes for simple identification of morphemes would be a convenient one" (p. 77). However, he also points out that the morphemic identity could not be identified hence, the concept was considered tentative. Pike (1947) also argued for dissolution of structural organization of levels and argued that the three hierarchical levels "phonetic, phonemic and grammatical analysis should proceed together" (p. 67) and the interlinked levels should be looked at as a whole. American Structuralist looked at phonemic analysis as independent of morphological analysis, hence the theory of morphophonemics could not be uniformly and consistently defined.

Prosodic phonologists like Firth (1935) laid emphasis on the importance of non-segmental features such as labiovelarization, palatalization, nasalization, etc. An example could be vowel harmony which means some features of successive vowels are similar. These features do not belong to the C-V system of sound. These non-segmental features were characteristic of a syllable and not just a segment. They focused on development of theory in place of methodology therefore dissolving the hierarchical organization of levels, thus intermixing phonological and morphological analysis. However it also points out that the phonological analysis must be done before describing morphology. The prosodic approach to look at phonological problems was also accepted by Harris (1944) and Pike (1947).

1.2.2. Generative Model

Transformational generative grammar became radical because of the non-independence of different linguistic levels of analysis. It proposed that the different levels of linguistic analysis were interdependent and linked. It also believed that the morphophonemic rules were intrinsically superior to the phrase structure grammar. The generative paradigm began with the work of Chomsky and Halle (1968). They rejected the watertight compartmentalization of morphological and phonological analysis. The nature of the theory is mentalist i.e. it aims at uncovering the Language Universals by being explanatorily adequate. Chomsky and Halle (1968), in *Sound Patterns of English (SPE)*, proposed that the phonological representations consist strictly of a linear sequence of segments, hence it is extremely segmental like Firth's systemic prosodic approach. The rules of grammar rely heavily on the criterion of 'economy', which means that the simplest analysis is the correct representation of natives' knowledge. The function of the generative grammar is to produce the grammatically correct structures of English language in the most elegant or economic manner possible. They state that there is no intermediate level between phonological and phonetic levels (Chomsky and Halle, 1968, p. 11). Hence, one essential part of the grammar is the phonological component in which are found all the phonological rules of the language, hence phonologically and morphologically conditioned rules were not differentiated. The surface representations were derived from the underlying form with the application of economic and simple phonological rules. Each segmental slot was assigned distinctive features (Chomsky and Halle, 1968, 64) and the application of "… phonological rules modify the segmental structure of a string of formative in accordance with the specified labeled bracketing" which resulted in modification or change of sound (Chomsky and Halle, 1968, p. 28). As the distinctive features were applied to segmental slots, it did not take syllable as a phonological unit. They take prosodic features, such as stress, to be suprasegmental features. Suprasegmental features apply on consonants and vowels, hence they have no independent existence. Also, the model had a lot of rules.

Hooper (1976) developed the **Natural Generative Phonology** as a natural reaction to the problem of abstractness. According to Durand (1990), this model proposed that

the underlying forms bear a direct relationship to the surface phonetic representations and "that abstractness should be banned from the grammar" (p. 134). The model also made a distinction between phonetically and morphonologically conditioned rules. Hooper (1976) has proposed that the surface forms are attained by the application of the following types of rules: via rules, spell-out rules, Morphophonemic rules (MP-rules), Sandhi rules and Phonetic rules (P-rules) (Durand, 1990, p. 144-145). Phonetic rules are the universal phonological rules which apply automatically. MP rules have a very specific morphological and/ or lexical context under which they apply, hence these are also not automatic. Via-rules define relation between two segments without any link or with no phonological context mentioned, hence these are very vague.

The non-linear phonological representation began after Chomskyan studies with the work of Goldsmith (1976, 1979) and Clements and Keyser (1983). We will study the following four non-linear models in the current section: Autosegmental phonology, Metrical theory, Syllable phonology and Moraic theory.

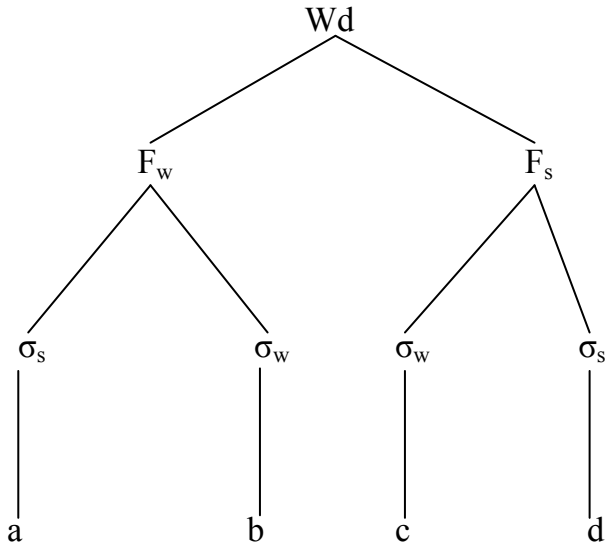
Autosegmental Phonology by Goldsmith (1979) examines tones in some of the African languages. The theory assigns tone to a tier different from tier for consonantal and vowel segmental features. This theory was able to account for many problems. Following the above, the representations in Phonological analysis began to be seen as non-linear hierarchical organization of phonological segments each having multi-tiered representation. Each tier is autonomous implying that the rules operating on one tier do not affect others (stability effect). The different segments on the tiers are associated with segments of other tiers by association lines. The association lines (Goldsmith, 1979, p. 19) are solid and the broken association lines with ǂ in it represent a change in the structure of the word. Goldsmith also gave well-formedness condition according to which "(1) All vowels are associated with at least one tone; All tones are associated with at least one vowel. (2) Association lines do not cross." (Goldsmith, 1979, p. 27). Therefore the phonological representations became more important than the phonological rules. The difficulty of representation of contour tones was resolved using Autosegmental phonology. Contour tones (Goldsmith, 1979, p. 21) are multiple tones attached to one vowel or syllable of a word. It looked at high

or rising tone as sequence of LH tone and the low or falling tone as sequence of HL tone. Therefore the assimilation rules became obvious, such as:

- Low tone rises when followed by a high tone and high tone falls when followed by a low tone.
- Low tone falls if preceded by high tone and high tone rises if preceded by a low tone.

Another problem solved by this theory is that of tone stability or preservation. Tone stability (Goldsmith, 1979, p. 30) is a process in which tone is preserved even though the unit (vowel or syllable) carrying the tone has deleted. In Autosegmental Phonology, tones are present on a different tier from the CV tier. Therefore, even after a segment of the word deletes, the tonal specifications are preserved and attested on the neighboring segment. The complexity of intertone or the effect of one tone on another shown in African languages in Autosegmental model is not observed in Punjabi language.

Metrical phonology deals with assigning segments into groups of relative prominence, where segments are organized into syllables, syllables into metrical, feet into phonological words and words into larger units. This organization is represented by metrical tress and grids. Liberman and Prince (1977) state that stressed syllables are marked strong (s) in relation to their unstressed syllables which are marked weak (w) (p. 394).



In the above representation, Wd stands for word, F for foot and σ for syllable which is either s (strong) or w (weak). In the above word, the first foot is weak whereas the second foot is strong. In the first foot, the first syllable is strong and the second is weak whereas in the second foot, the first syllable is weak and second is strong. Hayes (1983, p. 366) made the following relevant observations with respect to the derivation of grids from metrical trees:

i) "As a place marker, assign each syllable a mark on the first level of the grid.

ii) Assign sufficient additional marks so that the strongest syllable of every strong metrical constituent has more marks than the strongest syllable of its weak sister."

Hayes (1983, p. 368) creates a metrical grid for 'Mississippi legislation' using X which is as follows:

"
X
X X
X . X . X . X
Mississippi legislation "

The corresponding metrical grid for the word [dal.cɪ.ni] is is shown below.

X			Wd level
X	X		Foot level
X	X	X	Syllable level
dal	**cɪ**	**ni**	

The grid shows the relative prominence of units at syllable, foot and word levels. However, Sethi (1997) correctly points out that metrical model impose "arbitrary patterns of quantity and rhythm" on language description which poses problem when dealing with a weight sensitive language (p. 39).

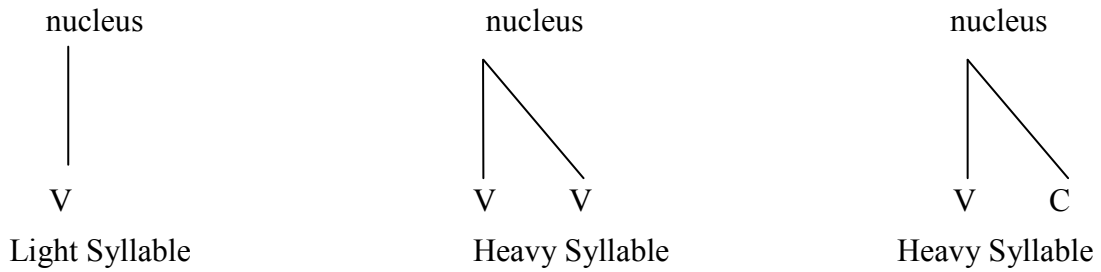
Syllable Phonology extends the stability effect as proposed by Clements and Keyser (1983). Here, core syllable is CV syllable which yields other syllable types by the application of below mentioned rules (Clements and Keyser, 1983, p. 28-30):

1. Delete syllable initial consonant

2. Insert syllable final consonant"

Clements and Keyser (1983) have also proposed the onset first principle (p. 37). According to this principle, the initial and final consonants in a syllable are maximized consistently with the syllable structure conditions of the language so, So, Punjabi can have a maximum of two syllable initial consonants as in [glas] 'glass', [pret] 'phantom', or two syllable final consonants in one syllable as in [gend] 'ball', [ɪkk] 'one'. This principle makes words like [mən.tri] 'minister', [ləcʰ.mən] 'a name' [muɳ.ɖa] 'boy', [kʰət.ri] 'a caste', etc possible. The syllable boundary (represented here by dot) explains the presence of consonant clusters across syllable boundary in the medial position of a word which otherwise are impermissible in the onset or coda position of syllables.

The syllable structure may change, when a morpheme is added to it. For example, [gaj.ri] 'carrot color' consists of two syllables gaj and ri phonologically, and $ represents a syllable boundary within a linear representation. However, if we look at the same morphologically, it is observed that the word consists of three syllables, two in the root word [ga.jər] 'carrot' and one in affix [i] 'suffix for making adjective'. However, as we will see later in the work, the addition of [i], leads to change in the syllable structure because of schwa deletion. The mismatch between the phonological and morphological information is taken care of using a syllable based prosodic approach in the context of phonology-morphology interface hence the same approach is adopted in the present work. Clements and Keyser (1983) have given the following representations for light and heavy syllables:

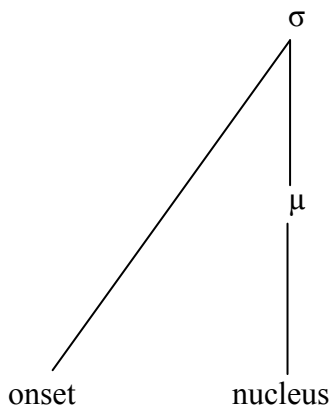


Light syllable has a short vowel whereas heavy syllable has either a long vowel or a closed syllable (a vowel and a consonant).

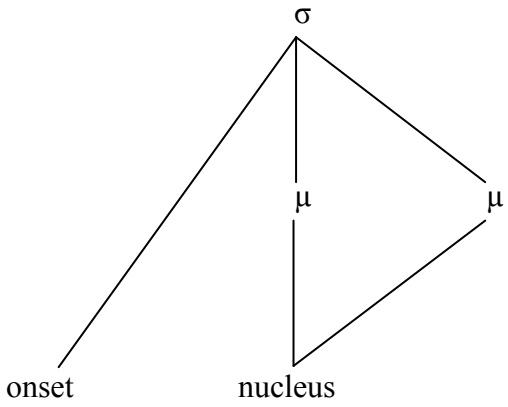
In classical SPE model, the feature content of the segments do not refer to any other structure but that of a segment and therefore these do not make any reference to the prosodic categories. The increasing significance of the syllabic unit led to the emergence of the syllable as the basic phonological unit in non-linear generative models. The concept of syllable with a reference to the hierarchical make up of syllables is extremely significant for the study of Punjabi. Syllabic theory is based on prosodic properties like accent. In the present work, the much needed attention has been given to the concept. The rules of accentuation are formulated in the work and these help in a better understanding of the much controversial concept of tones and schwa deletion in Punjabi.

Moraic approach is "… well suited for formal description of prosodic frame" (Hayes, 1989, p. 254). This approach is used in phonological representations of words in non-linear phonology. It has an extra level of representation that is mora. Mora is the minimal metrical time/ weight unit. Using moraic model, prosodic features of the nucleus such as syllabic weight can be easily represented. Singh (2004) also states that "moraic approach is considered as a very good approach for representing prosodic features" (p. 19). According to Hayes (1989), mora represents syllable weight hence light and heavy syllables have one and two moras respectively (p. 254). The syllable weight is determined by units represented by 'mu' (μ) that is nucleus and coda and hence, it is a separate representation level in prosodic phonology. Onset of the syllable doesn't determine the syllable weight hence it doesn't bear mora (p. 258). Prosodic features such as accent, tones, nasalization, etc are represented at μ-level. Thus, the changes made at one tier do not affect the other tier(s). There are three tiers shown in CV phonology- syllable tier, CV tier and segmental tier. In the present work, mora tier will be used in the place of CV tier as it is best suited to represent the prosodic features such as syllable weight, accent, etc. The segments/ units with μ determine syllable weight, and are very important in determining the place of accent

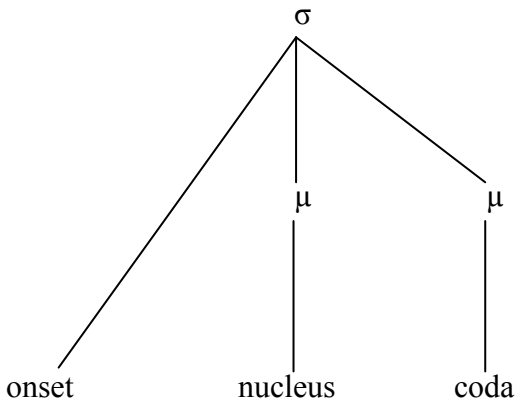
and tone in Punjabi. The representation of syllable with one mora, the possible two representations of bimoraic syllable and the representation of syllable-final geminates are given below (Hayes, 1989, p. 254 and 257).



Representation of a syllable with a single mora

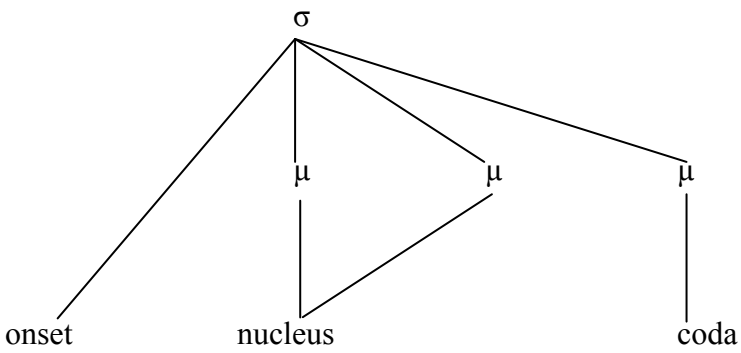


Representation of a syllable with two moras due to presence of a long vowel

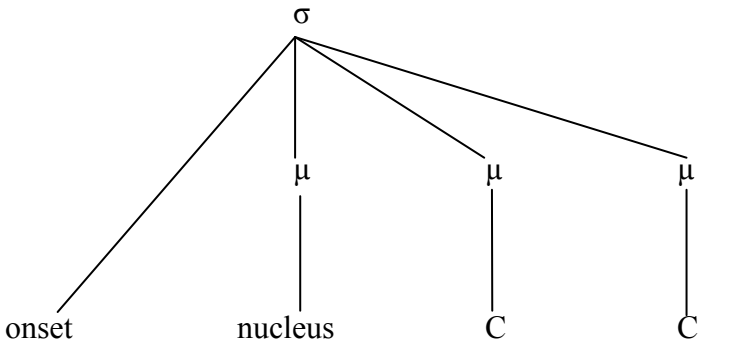


Representation of a syllable with two moras due to presence of coda after a short vowel.

Many have also adopted the same representation to study compensatory lengthening (Kiparsky, 2011, p. 1 and Karlin, 2014, p. 125). The concept of extra-heavy syllables was introduced by Gargesh (1999) for Punjabi language. His work implies the following two representations of extra-heavy syllables in moraic model. The structures given below are also adopted by Singh (2004, p. 33).



Representation of a syllable with three moras due to presence of a long vowel and a consonant in coda position



Representation of a syllable with three moras due to presence of a short vowel and two consonants in coda position

1.3. Literature review of work done on Punjabi Phonology

All the phonological work that has been done on the language is within two major paradigms of the twentieth century, viz, structural and early generative models. Till date all the work on Punjabi has either not given attention to the non-linear framework or has not studied the phonological problems at the interface. Different scholars have worked on different phonological problems such as accent, tone, intonation, schwa deletion and nasalization in Punjabi language. Let us review the work done on phonological problems in Punjabi in brief. The work done on these phonological problems in Punjabi will be examined in detail in the following chapters.

1.3.1. Structuralist Model in Punjabi

Some Indian phonologists have worked in structuralist model like Jain (1934), Malik (1995), Gill and Gleason (1969) and Gill and Gleason (2013). Jain (1934) studied Punjabi phonology but his work was limited mostly to phonetics. He has described sounds and has given twelve stories in phonetic script with their transcription. Jain (1934) also looks at the problem of schwa deletion diachronically and Sharma (1971) observes that there is a tendency to produce some Hindi words without schwa in Punjabi, however, he has not made any generalizations or given any rules. According to Bahl (1957), one sentence can have multiple presentations, each having different altitudes. Different sentences have different placement of altitude or pitch exponent. Gill and Gleason (1969) gave a detailed analysis of the segments (vowel and consonantal) and discussed tones in brief. They have compared the phonology of Punjabi to other Indo-Aryan languages like Hindi though the description applies to the literary variety only and doesn't pertain to the spoken form of Punjabi. They also recognize the significance of emphasis in discourse as one of the devices to analyze sentences, however, do not explain it in detail. Sharma (1971), Arun (1997) and Bahri (2011) have listed examples of nasalized vowels, without giving any explanation to account for its presence. Malik's (1995) work has talked about accent but didn't make any significant generalizations in regards with accent placement. Malik (1995) has also listed examples of both progressive and regressive nasalization in Punjabi but his work is descriptive in orientation and offers no explanations. Gill and Gleason (2013) have taken into consideration the spoken form of the language and also talked about phonological processes like tone, intonation, etc. They have also listed the examples of vowel nasalization, however, they have not made an effort to explain the phonological problems in the language. Attempts made by scholars in the structuralist paradigm have failed owing to lack of rules of syllabification.

1.3.2. Generative Model in Punjabi

Within the Generative perspective a distinction has been made between the linear approach and the non-linear or autosegmental approach. The work of some Indian phonologists like Kalra (1982), Bhatia (1993) and Gargesh (1999) also fall under this

perspective. Kalra's (1982) work is in linear perspective, he has used syllable weight to give rules for stress placement and schwa deletion, but his work gives a strong impression that Punjabi language has evolved from Hindi. Bhatia (1993) has also listed the phonemic inventory of the language along with all the consonant clusters possible in Punjabi. He has also discussed autosegmentals and morphophonology in brief. Gargesh (1999) proposes that a tripartite division of the syllables is needed to give the rules for the placement of accent in Punjabi. He also points out that the placement of tones in Punjabi is completely predictable and is highly related to the placement of accent. Masica (1991) and Yip (2002) points out that the realization of tones is related to syllable stress and historically voiced aspirated sounds. Singh (2004) has given rules for placement of stress, tone, nasalization and schwa deletion and is non-linear in orientation. His work is on Punjabi spoken in Delhi. Singh (2006) compared the intensity, pitch (minimum and maximum) and duration of the various horizontal and vertical sentences to study in Punjabi. By doing this, he has included experimental investigation and statistical processing in the research on intonation patterns of Punjabi.

Singh and Lehal (2011) have given 11 rules to predict occurrence and deletion of schwa in Punjabi. However, he neither took into account the concepts of syllable nor accent. Bowden (2012) has taken into consideration syllable weight to account for tones but didn't talk about accent. Kaur and Singh (2014) give four rules for predicting the occurrence or deletion of schwa for transliteration purposes, however, they do take into consideration the process of syllable.

Various scholars have accounted for phonological problems like placement of accent, tones in relation to aspiration, intonation, schwa deletion and nasalization, however, the explanation provided by various scholars has given either an incomplete or a very complex picture of the phonological processes in Punjabi. Most scholars working within the linear models of phonology have not taken into account the concept of syllable. There are still some unresolved/ unexplained phenomenon in the existing descriptions of Punjabi phonology. Many phonological problems in Punjabi arise due to the mismatch between the facts of phonology and morphology. The phonological

problems emerge in an interesting way in Punjabi at the phonology-morphology interface. There is a need to bring the concept of syllable and accent to the centre of the theory. Most of the work done on Punjabi has neglected the syllable as a constituent unit. Syllable needs to be taken as the most important prosodic component for examining word phonology in Punjabi.

1.4. Aim of the Present Study

The present work aims to study afresh the important phonological issues relating to syllable and syllabification, placement of accent, tones resulting from loss of aspiration, intonation, schwa deletion, nasal consonant formation and nasalization of vowels, glide insertion, alternation of high front glide /y/ with the back palatal voiced /j/, and occurrence of gemination by examining the data obtained from native speakers of Punjabi in India. The overall framework followed will be that of non-linear phonology with syllable as the basic prime. The correlates of the phonological features will also be experimentally verified and the phonological problems of Punjabi will be looked at from the point of view of prosody based non-linear generative phonology model and the syllable theory. This approach to the phonological problems of Punjabi is more natural and explanatorily adequate.

The study seeks to make a contribution by providing an insight into the phonology of Punjabi, by keeping the notion of syllable and accent at the center and by providing an experimental base for it.

The present work aims at applying the scientific theory which is explanatorily adequate and is based on the deductive approach to the Punjabi data. The multi-tiered syllable based prosodic approach to the understanding of phonological processes in Punjabi will be employed in the present work.

1.5. Chapter Division

Chapter 1: The review of literature of phonological theories and models has been provided in the first chapter. It also discusses the problems that will be discussed in

the present work and the review of work already done on Punjabi. The main aim of the study is also outlined.

Chapter 2: The second chapter discusses the theory of syllable which is to be kept central to solve the phonological problems in Punjabi. The outlook adopted in the work to solve the problems will also be discussed.

Chapter 3: The research questions and objectives of the present study will be listed in the third chapter. The justification for and limitations of the present work will also be highlighted in this chapter. The details of the participants such as their profession, gender, connection with native land, etc will be given. The tools used for data collection, recording and analysis will be talked about and the parameters used for experimental analysis of the problems will be defined.

Chapter 4: The placement of accent in words with different syllable weights will be studied using experimental means as well. The phonological problem of accent placement in Punjabi will be looked at from the point of view of prosody based non-linear generative phonology model and the syllable theory.

Chapter 5: The concepts of tones and intonation will be explored in the fifth chapter. The rules for predicting the type and placement of tones will be given which can be best understood by keeping the notion of accent in mind. The fall and rise in amplitude values will help determine the type of tone and pitch diagrams will be plotted to see the rise or fall in pitch. Further, the much ignored concept of intonation in Punjabi will be discussed. The parameters used for studying intonation experimentally will be discussed and comparisons will be made among different types of sentences using those parameters.

Chapter 6: The phonological problems of schwa deletion, nasal consonant formation and nasalization of vowels, glide insertion, alternation of high front glide /y/ with the back palatal voiced /j/, and occurrence of gemination will be looked at in the sixth chapter. Prosodic elements will help in providing an adequate solution to the above mentioned problems. The presence or absence of schwa and nasal consonants in the word will be checked on spectogram.

Chapter 7: The conclusions will be drawn in the final chapter on the basis of the understanding gained in all the previous chapters.

CHAPTER 2

SYLLABLE AND SYLLABLE STRUCTURE IN PUNJABI

The phonological problems emerge in an interesting way in Punjabi at the phonology-morphology interface. The phenomena operating the phonology-morphology interface needs to be looked at in the prosody based non-linear level. There is a need to bring the concept of syllable to the centre of the theory. The concept of syllable did not become the centre of generative model until the theories of non-linear models came up. However, it has not been given the central place in understanding of phonological problems in Punjabi. Most of the work done on Punjabi has neglected the syllable as a constituent unit. Syllables need to be depicted as tree diagrams thus showcasing all the significant phonological details in order to understand phonological processes in Punjabi words. Syllable needs to be taken as the most important prosodic component for examining word phonology in Punjabi.

The present chapter is divided into two major sections. The development of theory of syllable will be discussed in the first section. The structure of syllable and multi-tiered phonological representation of word will also be shown in the first section. The outlook adopted in the present work along with the multi-tiered phonological representation of the prosodic features will be discussed in the second section of the chapter.

2.1. Development of Theory of Syllable

The theory of syllable is prominent and the Ancient Indian Grammarian, Paṇini, has used syllabic weight to differentiate the prominence of syllables. According to Cardona (1988), Paṇini has talked about three types of syllable weights- light, heavy and extra-heavy (as mentioned in Singh, 2004, p. 4). Light syllable has a short vowel, heavy syllable has a long vowel or a short vowel followed by coda and an extra-heavy syllable has a long vowel followed by a consonant or it has a vowel with length more than that of two morae. Structuralist like Bloomfield (1933) and Hockett (1955) have also talked about the theory of syllable. Bloomfield (1933) stated "An utterance is said to have as many syllables (or natural syllables) as it has syllabics. The ups and down of syllabication play an important part in the phonetic structure of all languages" (p. 121). Pike and Pike (1947) made reference to the

constituents of syllable to understand phonological problems in Mazateco and claimed that "*Sounds in syllables (or morphemes) may occur in structural layers, or in series of 'immediate constituents'; an inner core comprised of a sequence of phonemes may, in larger structural sequences, on a higher layer of distribution, act as a single unit*." (p. 326). Hockett (1955) described the structure of a syllable in the word /hat/ as "… a single syllable, and consists of three constituents: an onset, /h/; a peak, /a/; and coda, /t/" (p. 52), however he did not use these concepts to solve the problems arising at the interface. Fudge (1969) has also stated that "the syllable is a phonological universal" (p. 370).

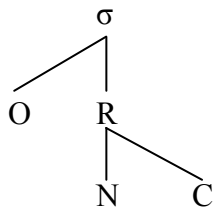
Selkirk (1982) gave three reasons to show that syllable is a theoretical construct. The first is that stating phonotactic constraints with reference to syllabic structure gives the most explanatory explanations. Second reason is that wide application of rules of segmental phonology can be explained via syllable. Third reason given in the support of syllable as a theoretic constraint is that suprasegmental phenomena can be treated well by grouping segments into syllable (Selkirk, 1982, p. 328). Selkirk (1982) also gave the Immediate Constituent principle of phonotactics, according to which, "onset, peak, and coda are units within which the tightest phonotactic constraints obtain" (p. 329).

SPE model is not syllable based though they have 'syllable' feature, it only refers to V or V-like sound having the potential of becoming a nucleus. CV phonology or syllable phonology assigned central role to syllable and its structure. The increasing significance of the syllabic unit led to the emergence of the syllable as the basic phonological unit in non-linear generative models. The concept of syllable with a reference to the hierarchical make up of syllables is extremely significant for the study of Punjabi. Syllabic theory is based on prosodic properties like accent. In the present work, the much needed attention has been given to the concept. The rules of accentuation are formulated in the work and these help in a better understanding of the much controversial concept of tones and schwa deletion in Punjabi.

Every language has a vowel in a syllable as nucleus/ peak and it is possible to have a diphthong as well. As earlier discussed in the first chapter, there can only be a consonant cluster of two at onset position or coda position of a word in Punjabi such as in [swad] 'taste', [glo] 'a herb', [dənd] ' tooth', [səpp] 'snake'. Syllable-initially a consonant cluster is possible only with liquids. It is not possible to have

consonant clusters at both onset and coda position as in CCVCC. The syllable structure may change, when a morpheme is added to it. We will see below how the addition of suffix leads to change in the syllable structure because of schwa deletion. The mismatch between the phonological and morphological information is taken care of using a syllable based prosodic approach.

The structure of a typical syllable is shown below:

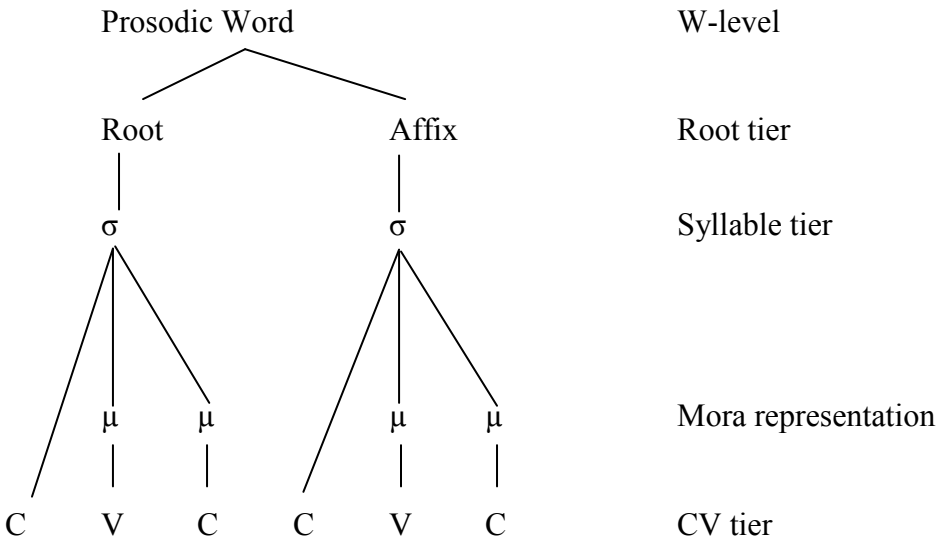


(Selkirk, 1982, p. 331)

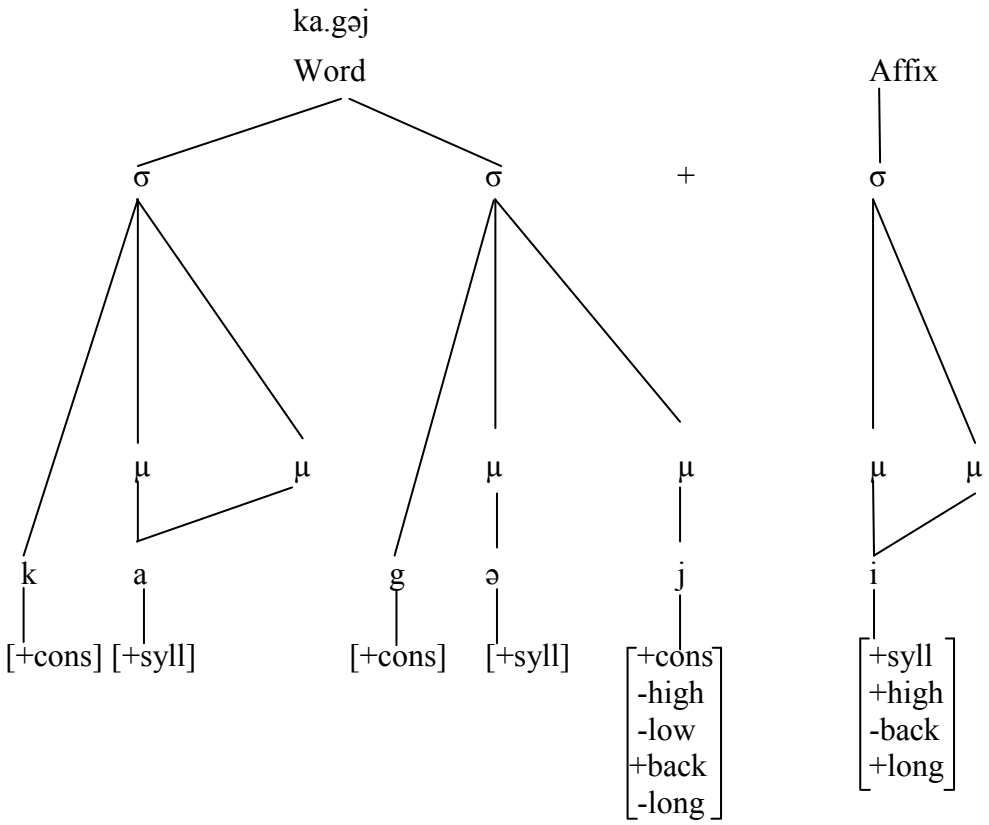
where σ is syllable, O is onset, R is rhyme, P is peak or nucleus and C is coda.

The syllable consists of onset and rhyme. Onset contains a consonant or a consonant cluster in the syllable before the syllable peak, rhyme consists of the syllable peak, i.e. nucleus and the consonant or a consonant cluster following the peak i.e. coda. O, N and C may be branching. If a syllable has initial consonant cluster then O will be branching. Similarly, if there is a syllable final consonant cluster, then coda will be branching, and nucleus will be branching in case it consists of a long vowel or diphthong.

The multi-tiered phonological representation of a word is shown below.

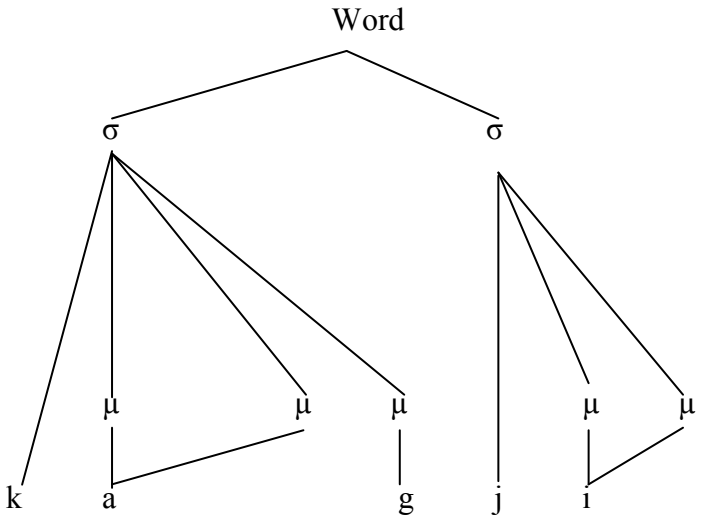


Since there are morphemes in Punjabi, the current model will be extended to be represented like the above. The present work will only look at the phonological representation but word representation is included to represent root and morphemes. CV tier will be combined with segmental tier in further representations when analysis of phonological problems is done, as distinctive features are the minimal unit of discrimination in phonology. Let us look at how the phonological representation of the word [ka.gəj] which means 'paper' in Punjabi changes on affixation of [-i] suffix which is used for making adjectives.



The above syllable structure changes, when the morpheme [i] is added to it. [kag.ji] consists of two syllables phonologically, however, if we look at the same morphologically, it is observed that the word consists of three syllables, two in the root word [ka.gəj] and one in affix [i]. The final representation of the word is shown below. We will study how resyllabification can change the internal structure of syllable in Chapter 6 in detail.

kag.ji ‘paperwork’



Hence, the addition of [i], leads to change in the syllable structure because of schwa deletion. The component consists of Word-level representation working with the phonology-morphology interface rules. The word-level (or the W-level) comprises hierarchically organized series of multi-tiered representations. The various phonology-morphology rules trigger modification(s) in the representation of the word between different levels. The last representation of the series satisfies all the conditions.

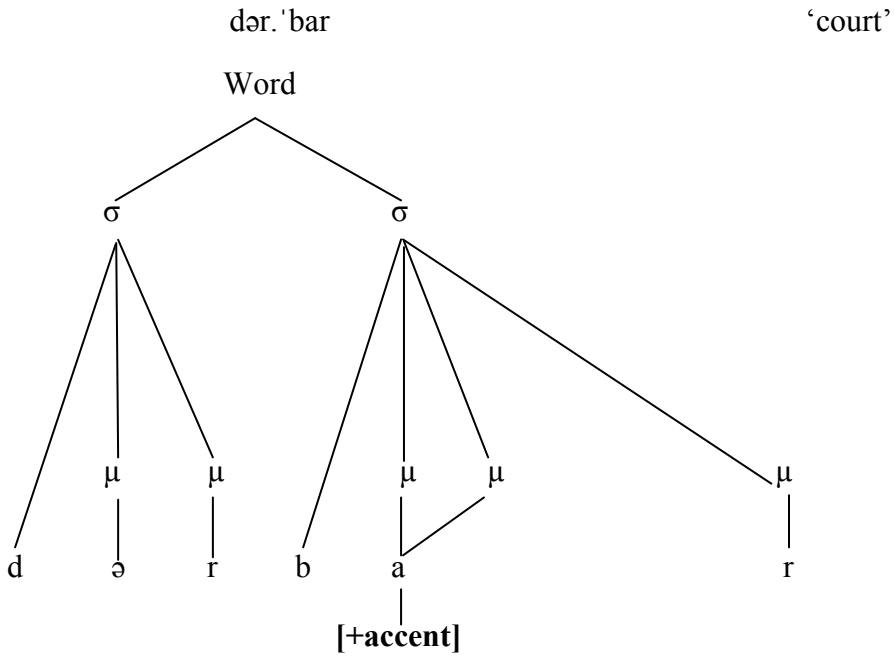
2.2. Outlook in the Present Work

The representation above takes syllable as the most important prosodic feature of word phonology. An understanding and use of the syllable structures will help to resolve problems that arise at the interface of phonology-morphology. Hence, the present work will keep the concept of syllable in focus and examine phonological problems in Punjabi. The multi-tiered representations express both phonological and morphological facts of the language. The phonological and morphological information is applied at the W-level to satisfy universal and language specific principles. The phonological rules bring about the structural change between two different w-levels. The representation of prosodic features will also be shown. According to Pike (1947) suprasegmental features apply at nucleus (p. 142). The multi-tiered syllable based prosodic approach to the understanding of phonological processes in Punjabi will be employed in the present work. Let us very briefly see how the phonological problems will be dealt with in the present work.

2.2.1. Accent

The present work aims to understand the placement of accent in words with different syllable weights. The present work will take a look at word accent in Punjabi by comparing accented and non-accented syllables in different word positions with respect to duration, amplitude and f0. The findings of the experiment will be helpful in determining the relation of the accent with- weight of syllable and their position in a word. The types of syllables on the basis of their weights will also be studied to be able to understand placement of accent.

The prosodic rules will be defined for placement of accent keeping syllable at the base to take care of the mismatch between phonological and morphological information. It makes the phonological rules simpler, more insightful and natural. Therefore, a syllable based prosodic approach is adopted in present work especially in context of resyllabification. The representation below shows how accent is placed on moraic level of the word.

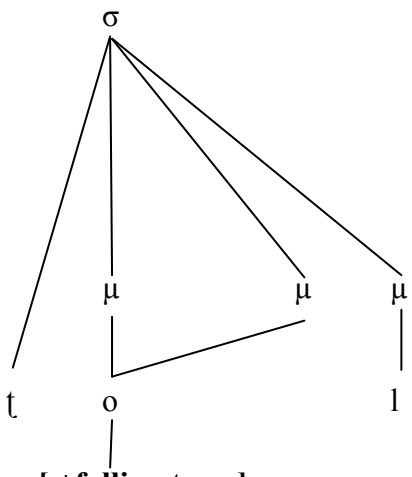


The representation above shows the placement of accent on the ultimate syllable in the bisyllabic word [dərbar]. The present work will look at the phonological problem of accent placement in Punjabi from the point of view of prosody based non-linear generative phonology model and the moraic theory.

2.2.2. Tones

The placement of tones is predictable in Punjabi. The placement and type of tones can be determined from the placement of accent and orthographically present voiced aspirated sound in the word. Tones have a synchronic relation with accent and a diachronic relation with voiced aspirated sounds, observed in its orthographic script. There is a strange relation between voiced aspirated sounds and tones in Punjabi. There are no voiced aspirated sounds found in spoken Punjabi.

ʈòl ‘drum’



(spoken variety)

The above representations show that a voiceless unaspirated sound with falling tone is present in the spoken variety, however there is a voiced aspirated sound in the orthography, in Prakrit and in Western Punjabi at the same place. The present work will focus on understanding the relation between the orthographically present voiced aspirated sounds in words and the tones attested in spoken variety in Punjabi. [ʈòl] ‘drum’ has a voiced aspirated sound in its orthography as in ਢੋਲ [lábˈ] ‘profit’ has a voiced bilabial aspirated consonant in word final position in the orthography as in ਲਾਭ. There are three ways in which tones develop in Punjabi on loss of aspiration, which will be discussed in the present study. The rules for predicting the type and placement of tone will also be given.

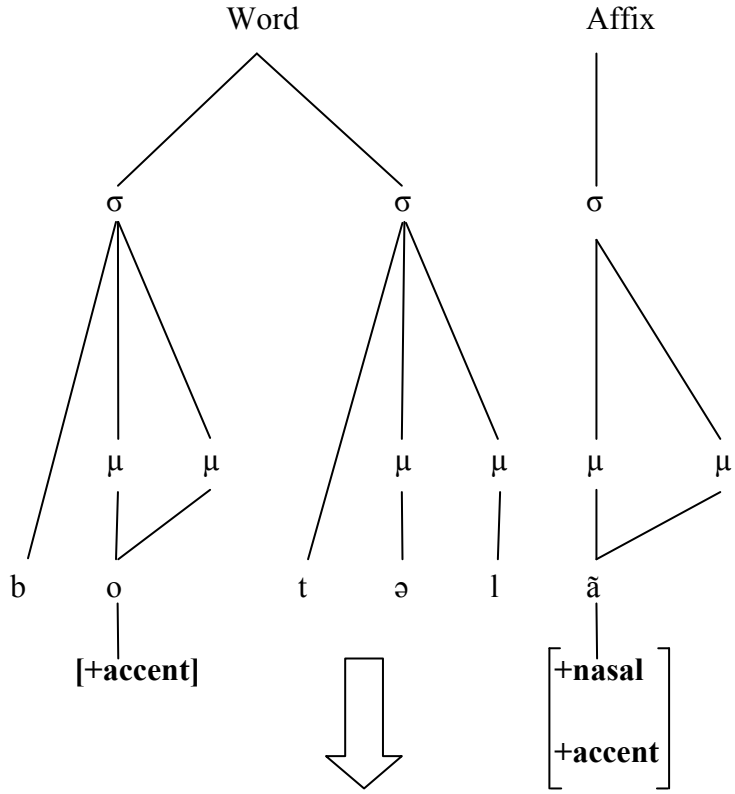
2.2.3. Intonation

Intonation conveys linguistic as well as paralinguistic meanings in conversation. The present work studies different intonation patterns in Punjabi and compares the duration, f0, minimum amplitude and maximum amplitude for different types of sentences. One intonemic level sentence has many intonetic levels which are discourse motivated. Intonemic level sentences are the underlined form of sentences whereas the intonetic levels are the different surface realizations of those intonemic levels. The differences in the acoustic findings of various horizontal and vertical types of sentences will be studied in the present work using duration, amplitude and f0 cues. Comparative analysis of the constituents of various intonetic levels will be done to get the complete picture of intonation pattern in Punjabi language. It is proposed in the present work that amplitude is an acoustic cue to the perception of intonation in Punjabi.

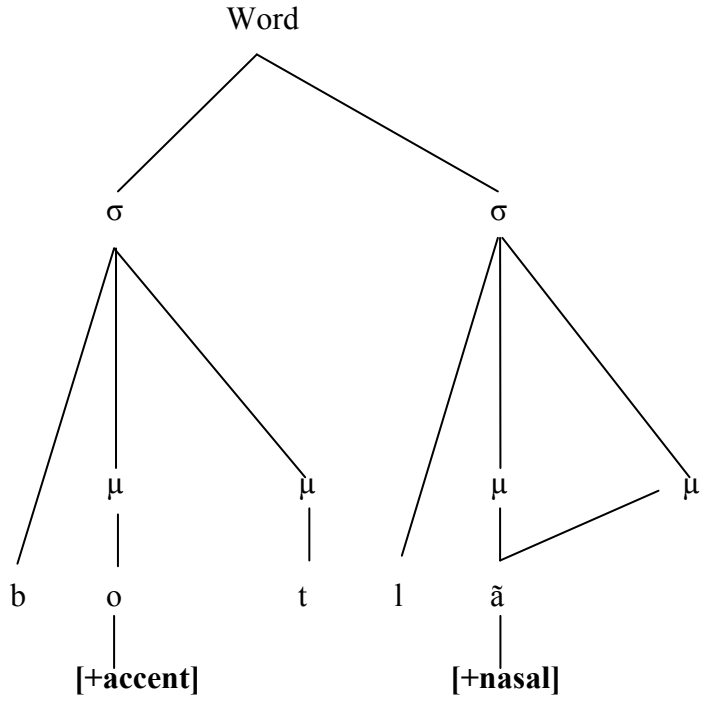
2.2.4. Schwa Deletion

The problem of schwa deletion may appear phonological in nature but it is emerging at the interface of phonology and morphology. The present work aims at explaining the problem in Punjabi language by providing an explanatorily adequate and less costly explanation within the (non-linear) prosodic framework. Schwa [ə] is the only vowel which is not visible in orthography of Punjabi overtly, hence, there is some ambiguity and indetermination with respect to its pronunciation in the language. The phonological and morphological factors determine whether the schwa vowel will be pronounced or not. Words like [botəl] ‘bottle’, [gərəm] ‘hot’, [əndər] ‘inside’ show schwa deletion on addition of affix, however affixation of [əp] with [man] ‘respect’ doesn’t lead to schwa deletion. This means that schwa deletion occurs at the ultimate syllable of a bisyllabic word if a suffix consisting of a heavy syllable is added as a morpheme. Hence, when the plural marker [ã] is added to the word [botəl] ‘bottle’, it becomes [botlã] ‘bottles’, showing schwa deletion, as represented below.

In the word [botəl] ‘bottle’, when the plural marker [ã] is added, it becomes [botlã] ‘bottles’, observing schwa deletion, as represented below.



The final representation of the word after resyllabification is given below:

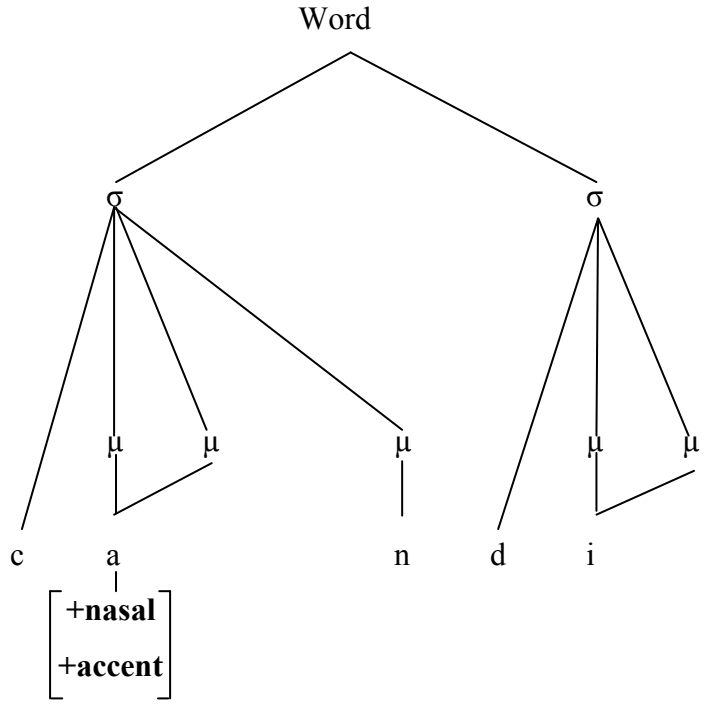


Hence, the present work aims to discover the environment in which schwa deletion can take place on affixation. It is important to take into account the concept of

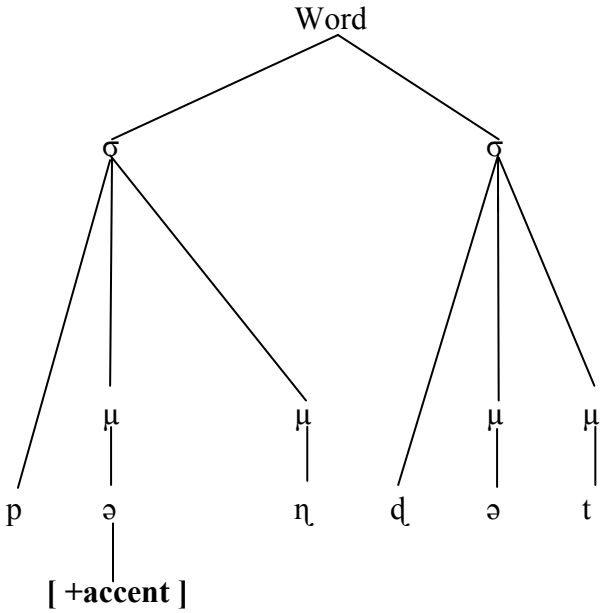
accentuation in conjunction with phonology-morphology perspective in order to predict schwa deletion in Punjabi. Spectograms will be used to see the presence or absence of schwa in the word.

2.2.5. Nasals and Vowel Nasalization

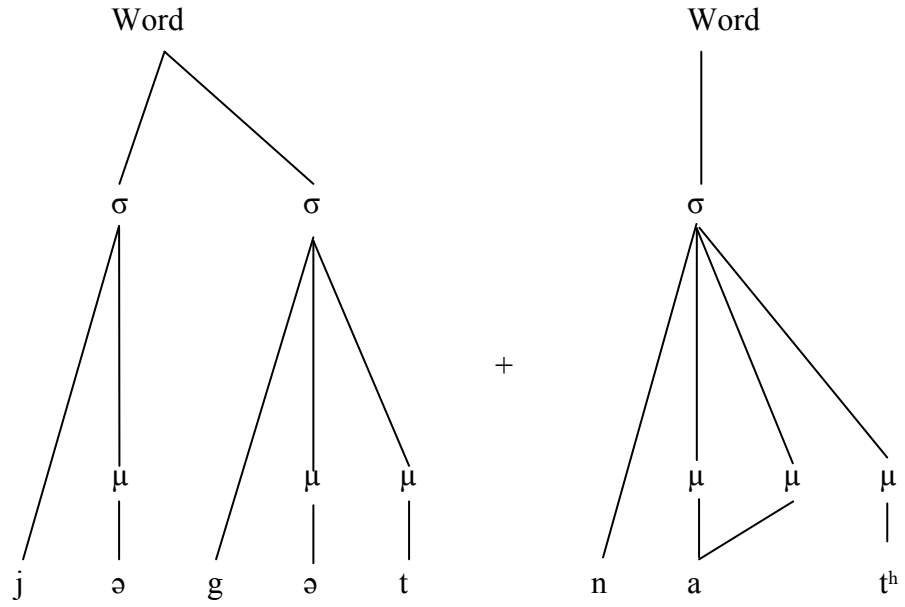
Nasalization is an important autosegmental and distinctive feature of Punjabi. However, it is also one of least understood concepts. The present work will look at examples to study the context where the vowels show nasalization in the vicinity of a nasal consonant. The underlying form of words with the nasalized vowels realized on the surface will also be proposed in the most economic way. The concept of accentuation will be used to explain the nasalization process. In words like [cãndi] 'silver', [gũŋga] 'dumb', [pɛ̃nti] 'thirty five', vowel nasalization is attested as shown below.



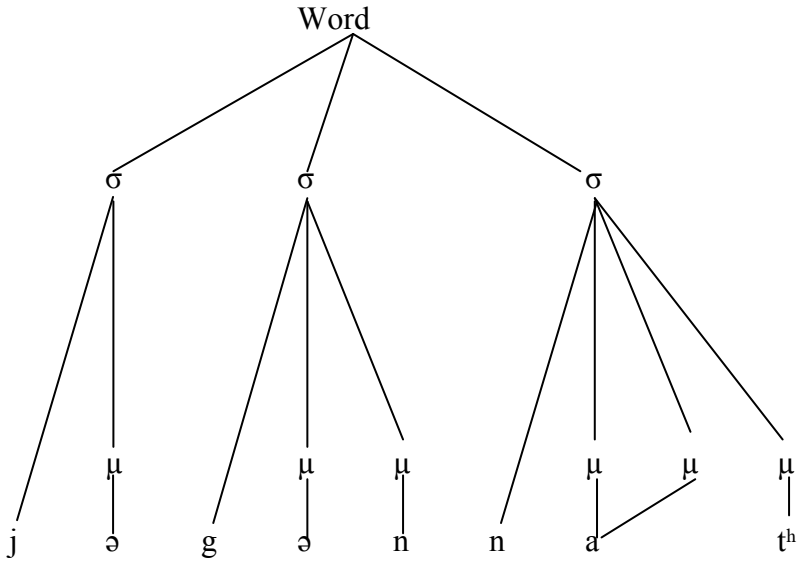
However, in words like [pəɳɖət] 'saint', [gend] 'ball', [pəɲj] 'five', the vowels are not nasalized in the environment of nasal consonants.



Assimilation is also observed in Punjabi at the interface of phonology and morphology. The context for assimilation and the extent of assimilation (full or partial) will be studied along with the direction of assimilation (progressive or regressive). Spectograms of the words will be studied to understand the above mentioned processes. The phonological representation of an example of regressive assimilation at the interface is shown below. The words [jəgət] 'world' and [nat^{h}] 'master' combine to form the word [jəgənnat^{h}] 'master of the world' showing regressive total assimilation.



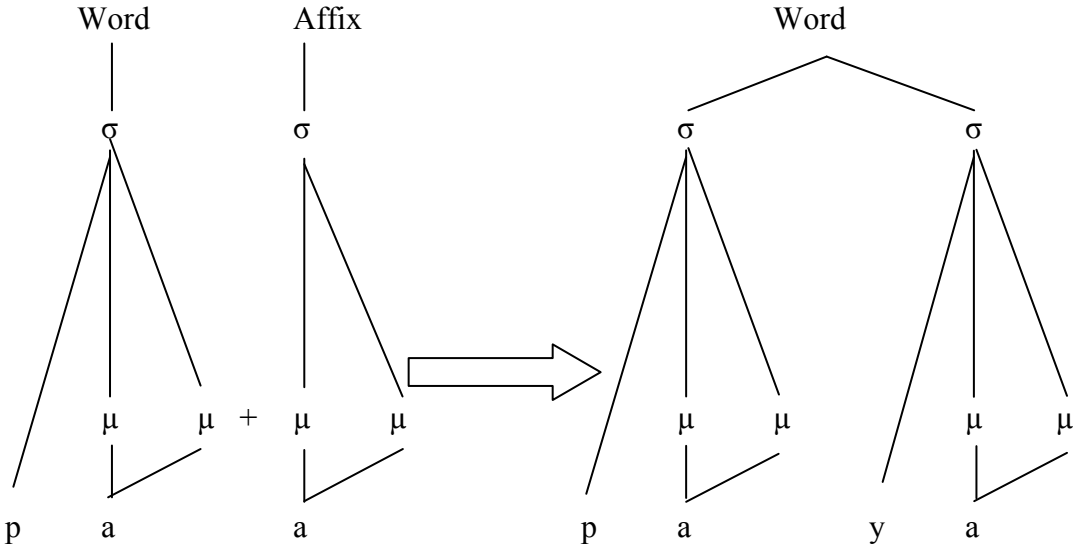
When the morpheme is added, the place of articulation matches due to regressive partial assimilation.



Therefore, the prosodic elements along with the phonological and morphological processes will help in providing an adequate solution to the problems like schwa deletion and nasalization.

2.2.6. Glide Insertion in Punjabi

It is observed that when morphemes join, there is insertion of glide at the morpheme boundary in some words as shown in the representation below. It shows the derivation of [paya] 'found' from [pa] 'find' on addition of suffix [-a].



The present work will look at the environment under which the glide appears and formulate the rule for glide insertion. The present work claims that this is a phonological problem that arises at the interface of phonology and morphology.

2.2.7 Alternation of high front glide /y/ with the back palatal voiced /j/

It is observed that there is alternation between the /y/ and /j/ in Punjabi such as in [yog] and [jog] 'meditation'. The present work will make an attempt to understand this alternation.

2.2.8. Occurrence of Gemination in Punjabi

Punjabi language has many geminates in its vocabulary such as [səpp] 'snake', [kəmm] 'work', etc. The Sanskrit forms of the words with gemination show that geminates occur due to total assimilation of neighbouring consonants, however the direction of assimilation is progressive in some cases and regressive in others (shown below). The present work proposes that this problem can be solved by using the concept of strength hierarchy.

Examples of Occurrence of Gemination			
Sanskrit	Prakrit	Punjabi	Gloss
sərpə	səppə	səpp	snake
kərɳə	kəṇṇə	kənn	ear
cərmən	cəmmə	cəmm	skin
əkʃi	əkkhi	əkk^{h}	eye
əgni	əggi	əgg	fire

The above-mentioned approach to the phonological problems of Punjabi is more natural and explanatorily adequate than any other. Keeping all this in mind, the processes of Punjabi like placement of accent, tones resulting from loss of aspiration, intonation, schwa deletion, nasal consonant formation and nasalization of vowels, glide insertion, alternation of high front glide /y/ with the back palatal voiced /j/, and occurrence of gemination would be discussed in this work. An interplay of prosodic features like accent with the phonological processes in the non-linear framework

would be explored. The intonation patterns in Punjabi, based on narrative data and elicited questions will also be described in the present work.

2.3. Conclusion

The development of theory of syllable is discussed in the chapter. The concept of syllable as defined by different phonologists is looked at in detail. The understanding of Paṇini, Bloomfield (1933), Hockett (1955), Fudge (1969), Selkirk (1982), Clements and Keyser (1983), etc of the theory of syllable is discussed in the chapter. The structure of a typical syllable and the multi-tiered phonological representation of a word are shown.

The outlook adopted in the work to solve the problems of accent, tones, intonation, schwa deletion and nasalization are also discussed. The representation of the prosodic features in the phonological representation is also shown in the chapter.

CHAPTER 3

METHODOLOGY

The goal of generative theory has always been the search for an explanatory adequate characterization of language properties. This present work aims at applying a scientific and explanatory adequate theory for data analysis of Punjabi. The ideology adopted for collecting the data of the present study is objective and quantitative. The data for this study has been taken from twenty two speakers of Punjabi. The study employed quantitative methods by empirically analyzing the recorded speech sounds. The acoustic values were obtained from the software which was also used to record and analyze the data, thus maintaining the objectivity. The data was further analyzed using descriptive statistical analysis and ANOVA test to yield results that could be generalized for larger population and to calculate significant variation in the data. It is vital to make sure of the validity of the data analysis instruments; this leads to objective judgment, valid and generalizable findings. The material recorded on PRAAT software v. 6.0.14 was analyzed carefully by the researcher. Conclusions will be drawn from the results arrived at. The literature available in the books is used to give a descriptive account of the phonology of language in question. Phonological problems are discussed in the context of their environments and in the non-linear framework.

According to J. Ohala (2007), experimentally supported theories are better evolved. He further elaborates that scientific methods have three key elements- objectivity, numerical quantification and evidence that supports theory (p. 5). Hence, the data for the present work is analyzed using experimental means to maintain objectivity and is represented quantitatively to avoid ambiguity. According to Hyman (2007), the field of experimental phonology has transformed, hence he stated that "An old-style tonal analysis, for example, which would have been accepted based on the word of an informant worker, might now instead be met by demands to see pitch tracings" (p. 7). Thus, there is a need to support phonological theories with experimental findings to make valid claims so the present work has included experimentation to study phonological problems.

The present study aims to collect and examine extensive data the speakers of Punjabi and attempts to provide an insight into the existing phonological problems. The study examined the following phonological processes in Punjabi: accent, tones, intonation, schwa deletion and nasalization. The following sections will outline the research questions that motivate the present study and describe the methodology with respect to subjects, data collection and analysis. The material presented in the following pages is the empirical data gathered from native speakers of Punjabi for cross-sectional study of phonology of the language.

3.1. Research Questions

In order to understand the phonology of Punjabi, the following research questions were raised:

- What is the role of syllable in determining accent placement in a word?
- What factors contribute towards placement of accent in a word?
- What are the acoustic cues to accent in Punjabi?
- Does Punjabi actually have tones?
- What is the influence of accent on tones?
- Is amplitude an acoustic cue to intonation pattern in Punjabi?
- What differences exist between the various intonetic levels in Punjabi?
- How can the problems of schwa deletion, and nasals and nasalization be accounted for?
- Does accent have any role in understanding these two problems?

The research questions led to the formulation of research objectives, which are discussed in the next section.

3.2. Research Objectives

The study aims to look at phonological problems in Punjabi by keeping the concepts of syllable and accent in the center. The aim of the study is to provide an experimental base for the solutions offered in the study. The objectives of the current study are enumerated below:

a. To examine the placement of accent and formulate rules for its placement by keeping syllable into center.

b. To study the placement of accent in words with affixes, in the context of phonology-morphology interface.

c. To figure out the relation between tones and voiced aspirated sounds.

d. To examine the placement and type of tones present in Punjabi acoustically and formulate phonological rules.

e. To analyze the differences that exists between the various intonetic levels in Punjabi.

f. To account for the problem of schwa deletion, keeping the notions of syllable and accent in center and looking at the problem in the context of phonology-morphology interface.

g. To study the problem of nasals and nasalization in Punjabi.

The primary objective of most of the linguistic studies including this one is to search for an explanatory adequate characterization of language properties. The above objectives are to understand the existing problems and gaps in the current explanation of phonology of Punjabi, and thereby, provide an explanatorily adequate solution to the problems.

3.3. Justification of the Study

The present study contributes to the field of linguistics, especially to Punjabi language in the following ways:

1) The study provides an insight to the phonology of Punjabi. The problems have been looked at and accounted for by various scholars, however some gaps are still there in the existing explanation. Due to this the current study investigates the phonological problems keeping the notions of syllable and accent in the center.

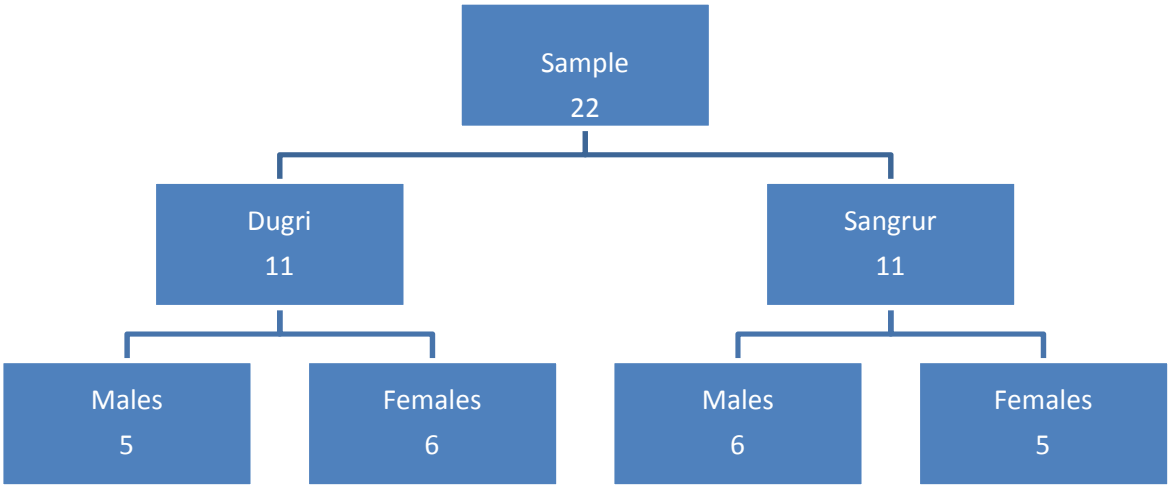
2) In addition to a theoretical perspective, the present study involves the use of experimental means for studying the language data collected from native Punjabi speakers. This provides an objective basis to Punjabi which is distinct from the earlier largely perception based studies. The current research has

employed PRAAT software v. 6.0.14 to analyze the data acoustically in order to arrive at conclusions.

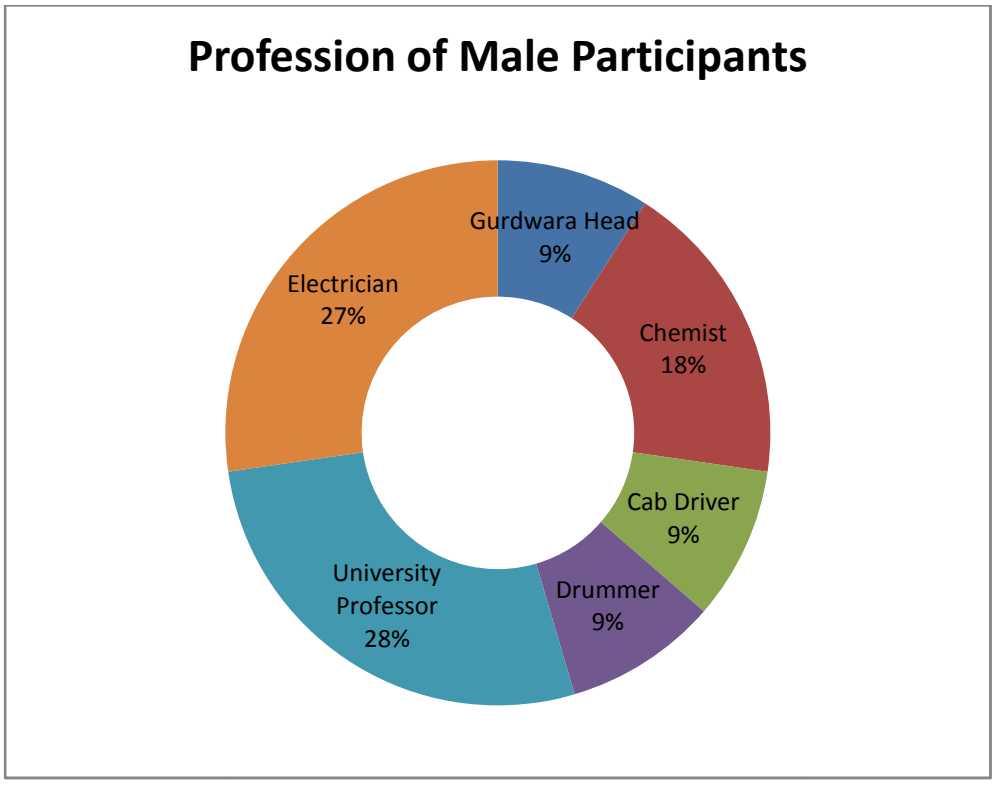
3.4. Participants

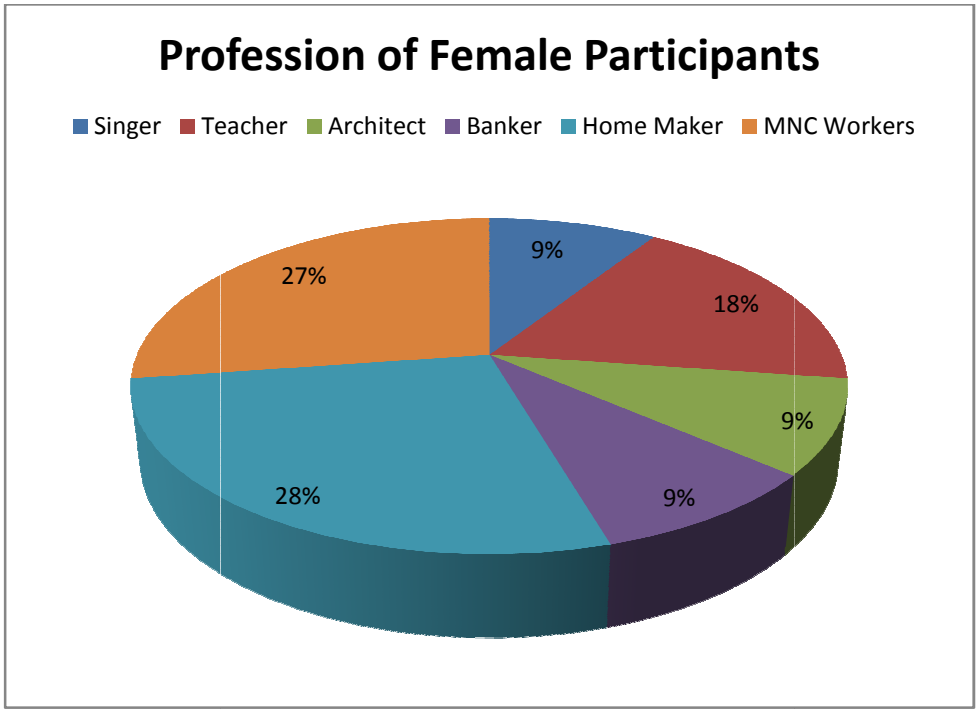
Twenty two native speakers of Punjabi from Dugri and Sangrur regions of Punjab (shown in a map of Punjab in Appendix II) volunteered for the study. The participants were between the age of 22 to 35 and none of these participants reported to have any speech or hearing problem. Apart from Punjabi, some of the participants are good speakers of Hindi and English, however their native language is Punjabi.

- These two regions were selected as the dialect of Punjabi spoken in these two regions is the standard (Malwai) dialect of Punjabi and the speakers from there two regions were easily available.
- Gender as a factor was kept neutral and balanced in the study, hence the same number of men and women were chosen for the study.
- Participants were chosen from varied socio-economic backgrounds to capture maximum variety and make generalizations which are valid for all speakers of the community in general.
- Participants chosen have maintained a close connection with their native places. All of these participants spend at least 30-50 days in Punjab every year.



Flow diagram of the sample





The above two diagrams summarizes the background information regarding the details of the profession of the participants.

The present study also collected data on tones from two speakers of Western Punjabi in India. Both the participants were in the age bracket of 80-90 years, hence the data from these two participants was collected at their homes and not in soundproof digital lab. The participants reported that they converse with their relatives in Western Punjabi on a daily basis.

3.5. Pilot Study

A pilot study was undertaken to form hypothesis, improvise the data list and to get a feel of the language. A data list with a number of words was prepared to examine the following phonological processes:

- Accent
- Tones
- Intonation
- Schwa Deletion
- Nasals and Nasalization

The data list was given to ten native speakers of Punjabi and they were being asked to read out the sentences and words from the list. It was observed that there was a need to add more words to ensure that the syllables of all types (different syllable weights, different vowels, open/ closed syllables, etc), in different word position were covered. The final data list is attached in Appendix.

3.6. Data Collection

The words/ sentences were written in Gurumukhi script with the English gloss, on plain white sheets. There was only one word/ sentence on one sheet. The sheets were shuffled randomly and given to the participants. The participants were asked to familiarize themselves with all the words/ sentences before starting the recording. Each participant was being asked to read out every word/ sentence once. The data list recorded for the above purpose is given in Appendix.

The data collection method adopted for studying intonation is discourse motivated. Hence, the participants were being spoken to before they uttered the response from the data list in desired intonetic levels.

3.7. Data recording

The utterances were recorded on PRAAT software v. 6.0.14 (Boersma & Weenink, February 2016), sampling rate 22.05 kHz and 16 bit quantization. PRAART software was used for recording and analyzing the data as it is an open source, easily available free of cost for acoustic analysis of the speech sounds. The tutorials are easily available, and the software gives values of the acoustic parameters in tabular form which can be easily analyzed, thus making this software the most preferred choice of the researchers.

The participants were alone in a soundproof room when they recorded the data and were allowed to take break(s), as and when needed. The data from each participant was collected in four sessions of about two hours each.

3.8. Data analysis

The utterances were analyzed using the PRAAT software v. 6.0.14. It is to be noted here that, for accent and tones, the measurements were made for only rhyme only since the accent and tone bear a close relationship with the weight of the syllable and the weight of the syllable is determined by the rhyme of the syllable.

The test item was annotated and the analysis was done using the following parameters:

Table 1: Phonological processes and the parameters used to study them

Phonological process	Parameters
Accent	Duration, maximum amplitude and f0 values of rhyme in all the syllables in the test word. Pitch diagrams were plotted to compare the pitch of different syllables in the word.
Tones	Pitch diagrams were plotted to see the difference in the rising and falling tones in the language.
Intonation	Duration, f0, minimum amplitude and maximum amplitude of all the constituents in the sentences were measured. The pitch diagrams were plotted to understand the pitch differences among various intonetic levels.
Schwa deletion	The spectrograms of all the schwas in the words before and after affixation were studied to see the presence or absence of schwa.
Nasals and Nasalization	The spectrograms of all the nasalized vowels, vowels in the vicinity of nasal consonant and words showing nasal assimilation were studied.

The justification for selecting the above mentioned parameters for studying phonological processes is mentioned in the sections dedicated to those particular phonological problems.

3.8.1. Parameters

Sound can be studied physically or psychologically. Measuring sound physically would mean recording the sound and analyzing it using instruments whereas measuring a sound psychologically would mean listening to it and reaching conclusions which could be different for different people. Hence the present work has used physical parameters to analyze the language. Pitch and loudness determine the quality of speech sound. Fundamental frequency and amplitude are their respective controls which have a one-to-one correspondence with pitch and loudness.

3.8.1.1. Duration: It refers to the time taken by the speaker to utter the test item. It is measured in milliseconds (ms). It is considered to be secondary correlate for the analysis of speech. It is affected by placement of accent in the language, placement of syllable in word, rate of articulation, etc.

3.8.1.2. Fundamental frequency (f0): f0 is the primary correlate of tone and intonation at syllable and sentential levels respectively. Fundamental frequency refers to the number of oscillations in a second. It is measured as per second or Hertz (Hz). A frequency of 5Hz would mean 5 oscillations in one second. Frequency is the physical term for pitch. Therefore pitch is the frequency perceived by human ear. The higher the pitch, the higher the frequency will be. The lower the pitch, the lower the frequency will be. Frequency depends on the number of oscillations made by the speech sound in a second. Normally humans can perceive frequencies ranging from 20 Hz to 18,000 Hz.

3.8.1.3. Amplitude: Pitch and loudness are the two most perceptible features of speech sound. The loudness of speech sound is measured as amplitude. Amplitude refers to the distance between the highest and lowest point of a cycle. It depends on sound pressure, spectrum, distance of sound source to recording device and duration of speech. The louder the sound, the larger the amplitude will be. The softer the

sound, the lesser the amplitude will be. Amplitude depends on the size of the oscillations. Amplitude is measured in Pascal (Pa). Intensity is also a measure of loudness of speech sounds, it is measured in decibel (dB) which is a broader unit. Pascal, on the other hand, is a smaller unit so it allows the researcher to look at data minutely.

3.9. Statistical Analysis

t-test was conducted to study the difference in accented and non-accented vowels. p-values, mean and variance were calculated using the same. ANOVA test was used to study the difference in maximum and minimum f0 values for words with tones on them. ANOVA test was chosen for statistical analysis to calculate p-values to find the significant variation. This software was chosen as it runs statistical tests quickly and is easy to use.

Since spectograms and pitch diagrams could not be shown for all the 22 participants, the f0 and amplitude values for a word (for all phonological processes except intonation) and a simple declarative sentence (for intonation) was calculated for all the participants. Statistical tests were run on these values and median was calculated. The data for the participant with median value is further used in the present work to show intonation.

3.10. Variation in data

The data was collected from the speakers of only one dialect of Punjabi i.e. Malwai, hence it was expected that there will not be much variation in the data recorded from the different speakers. However, it was observed that some speakers showed strong retroflexion and some of the speakers did not show retroflexion in nasal in words like [dʊkaɳ], [kəsaɳ], [jamiɳ], etc. This observation is not limited to nasal consonant. After taking a very careful look at their socioeconomic background, it was observed that the speakers from Sangrur region did not show retroflexion in these words whereas the speakers of Dugri region showed retroflexion. Therefore, it seems to be region specific. The alternation in retroflexion is shown in the appendix where all the data collected for the present study is listed.

3.11. Limitations to the study

The present study has some limitations owing to the small sample size. Being a cross-sectional study, conclusions and generalizations are based on the data collected from the speakers of a small region in Punjab and give no insight or observations on the phonology of Punjabi in general.

In the next three chapters, the results based on the data collected from the Punjabi speakers are discussed.

3.12. Conclusion

The methodology with respect to subjects, tools, data collection and analysis is described in the chapter. The research questions and objectives of the present study are listed in this chapter. It also discussed how the present work is justified and limitations to the study. The details of the participants such as their profession, gender, connection with native land, etc are given. The tools used for data collection, recording and analysis are discussed in detail and the parameters used for experimental analysis of the problems are defined.

This present work aims at applying a scientific and explanatory adequate theory for data analysis from standard dialect of Indian Punjabi. The ideology adopted for collecting the data of the present study is objective and quantitative. Quantitative and statistical methods are used to analyze the data. The importance of the present study lies in the fact that no large-scale study has been done to assess the phonology of Punjabi, especially using experimental means.

CHAPTER 4

ASPECTS OF PUNJABI PHONOLOGY I

All those features which can be stated on syllable level or on word level are prosodic features. The presence of prosodic features changes the meaning of the word, so they are phonemes. These features cannot be segmented as they are expanded to over more than a segment. Prosodic features include accent, tone, intonation, nasalization, etc. The present chapter will focus on an important prosodic feature in Punjabi language- accent and its placement in the first section. It is also important to keep in center the notion of "syllable" as it is the most important prosodic unit in understanding the placement of accent and has a bearing on it. The placement of accent in words with affixation will be looked at in the second section and rules for placement of accent are formulated in Punjabi in the third section.

(Note: Some of the examples used in this and the following chapters bear tone, which will not be marked to concentrate on the point/ topic being discussed in the section and tones will be discussed separately in fifth chapter)

4.1. Accent

Some linguists have used the terms 'stress' and 'accent' interchangeably. But since Bolinger (1958) and Pierrehumbert (1980), accent has come to refer to the cumulative prominence caused by pitch movements that marks syllable as focused or emphasized. Stress on the other hand is just part of the sound make up of the word, like consonants or vowels, therefore it is not meaningful to measure it. Sluijter and van Heuven (1996) state "Accentuation is used to focus and is determined by the communicative intentions of the speaker, i.e., accentuation is dependent on language behaviour. Stress is a structural linguistic property of a word that specifies which syllable in the word is the strongest" (p. 2471).

Punjabi speech is accented as it has one syllable relatively more prominent than other syllables in the word. The present work aims at discovering the rules for the placement of the prominent syllable or accent in words of the language and

confirming the acoustic parameters that can be used to measure it. Accent discussed in the present work is primary. Understanding of accent in Punjabi can answer several phonological problems of the language, as we shall see in the following chapters. Scholars have unanimously agreed that there is accent in Punjabi, and have given rules for its placement in Punjabi. We will see below that there is no agreement among the scholars with respect to the rules for placement of accent in Punjabi. Hence, the present work will look at the problem of accentuation afresh and give the rules of accentuation supported by experimental findings, by taking into consideration the morphological realities of the language, weight of syllable, and its position in a word. The diacritic (ˈ) is used to show accent on syllables.

The transcription in this section uses the transcription as used by the scholars themselves. Many Indian phonologists have talked about accent such as Bhatia (1993), Gargesh (1999), Singh (2004), Bahri (2011), Luthra and Singh (2012), etc. Scholars like Bahl (1957), Arun (1997), Bhatia (1993), etc have not considered accent to be a very significant feature. According to Arun (1997), accent is sometimes phonemic and is always on the same syllable which bears tone. Bhatia (1993) states that accent has significance only in distinguishing between grammatical categories in bisyllabic words (p. 343). Scholars like Sharma (1971), Clivio (1966) etc have considered accent to be a very significant factor, hence they have given rules to predict the placement of accent in Punjabi. The rules given by Sharma (1971) for the placement of accent are unsystematic because of the lack of reference to position of syllable. Joshi (1972, 1973) has looked at accent through the effect it has on pitch contrasts on every syllable, thus it has no phonological relevance. Clivio (1966) states that accent is on the first syllable with long consonant and on the first syllable with a long vowel if there is no long consonant. If there is neither a long vowel, nor a long consonant, then the accent is on the first syllable of the word (Clivio, 1966, p. 4). Tolstaya (1981) has proposed that the placement of accent in Punjabi depends on number and distribution of syllable in the word (p. 10-11). It proposes that the accent falls on the first syllable in bisyllabic words, and in trisyllabic words it falls on the second syllable when it is long, else it rests on the first syllable (p. 11). Dulai (1989)

has given the exact same rules for bisyllabic and trisyllabic words as those given by Tolstaya (1981) (p. 33-34).

Bhatia (1993) claims the accent is on ultimate syllable if the penultimate syllable has a centralized vowel and the ultimate syllable has a consonant cluster, eg. [a.ˈnənd] 'joy', the accent is on the penultimate syllable if it is long and ultimate is closed (eg. [ˈga.jər] 'carrot') or when the ultimate syllable is open, eg. [ˈma.li] 'gardener'. In trisyllabic words, the accent is on penultimate if it's heavy, else it's on antepenultimate syllable, eg. [ˈcəm.ki.la] 'shiny' and [ˈpın.jə.ra] 'cage' (p. 343). Malik (1995) has also given rules for placement of accent. He gives the rules for placement of accent, however he also pointed out some counter-examples for the rules he proposed (p. 80-84). He states that in bisyllabic words, the second syllable bears the accent if it is long and the first one is short, eg. [də.ˈler] 'bold', [ə.ˈkhir] 'atlast'. However, in certain cases the first syllable bears accent, despite being short, eg. [ˈsə.da] 'always', [ˈrəs.si] 'rope'. The accent can be on any syllable if both are short. For example, the accent is on the first syllable in [ˈdər.jən] 'dozen', [ˈdʊʃ.mən] 'enemy' and on second syllable in [ə.ˈcəl] 'immovable', [sər.ˈhədd] 'frontier'. Similarly, for trisyllabic words, the accent is on the second syllable mostly if all the syllables are long, eg. [var.ˈda.tã] 'incidents', [va.ˈve.la] 'uproar'. However in some words, it is observed on the first syllable, eg. [ˈdal.ci.ni] 'cinnamon', or on the last syllable, eg. [da.ɳe.ˈdar] 'granular'. The accent is on the second syllable mostly if all the syllables are short, eg. [bə.ˈhət.tər] 'seventy two', [pə.ˈvıt.tər] 'sacred'. However in some words, it is observed on the first syllable, eg. [ˈə̃.bər.sər] 'Amritsar city'. Also, in some words, there is variation, for eg. in [kə.miʃ.nər] 'commissioner', the accent can be on the second or on the third syllable. If the first two syllables are short and the third is long, the accent can be on the first (eg. [ˈchʊʈ.kə.la] 'witty remark') or on the second (eg. [nə.ˈkəm.ma] 'worthless') syllable. If the last two syllables are short and the first one heavy, the accent can be on the first (eg. [ˈvya.kə.rəɳ] 'grammar') or the second (eg. [do.ˈhət.thəʈ] 'slap with two hands') syllable. Therefore the rules given by Malik (1995) have a lot of counter-examples. Kalra (1982) has made a distinction between stress accent (considered a part of intonational contour)

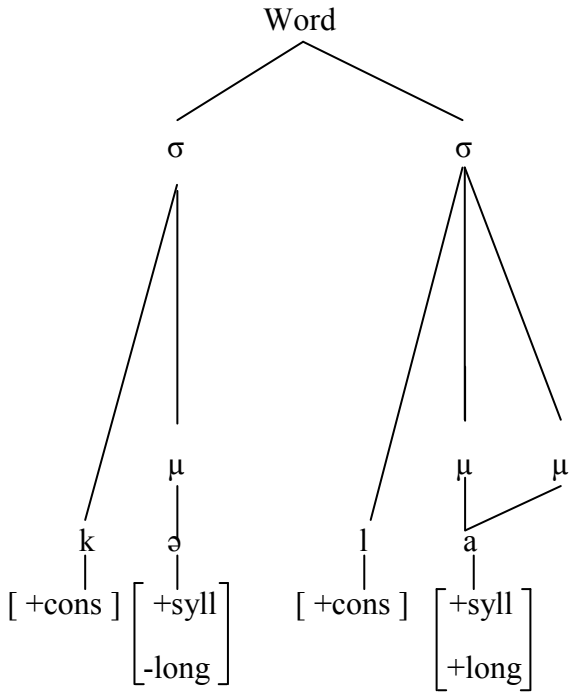
and pitch accent (having physical property) (p. 40-43). He proposes that placement of stress is predictable in Punjabi and that the rightmost heavy syllable but non-final syllable gets the stress. In case, there is no heavy syllable in the word, the leftmost syllable gets the stress (Kalra, 1982, 57-59). Bahri (2011) states that long syllable carry stress. The stress is on penultimate syllable if both penultimate and ultimate have same vowel length. He also states that stress is present before long consonant or conjunct (p. 17). Luthra and Singh (2012) propose that the accent is on the long middle syllable in a polysyllabic word (p. 41). One can clearly see here that many scholars have given rules for the placement of accent in Punjabi however there is a lot of variation and the rules are contradicting each other.

Gargesh (1999) claims that syllable weight is of utmost importance in predicting the placement of accent in Punjabi. He states that, in bisyllabic words, the ultimate syllable is accented if extra-heavy else penultimate is accented. For trisyllabic words, it is proposed that antepenultimate is accented if penultimate is light, else penultimate is accented. Singh (2004) too takes the notion of extra-heavy into account for giving the rules of accent placement. He lists all the common patterns attested in the language and the rules for those. He states the same rules for accent placement as given by Gargesh (1999).

It is observed by Gargesh (1999) that the tripartite division of the syllables is needed to give the rules for the placement of accent in Punjabi. There is a significant relation of the prominence of a syllable with its weight and position in a word. Therefore, it is important to take a look at the types of syllables before examining the accent in Punjabi. It is to be noted that rhyme has a role in determining the weight of the syllable. Hyman (1985) also pointed out that the syllable weight depends on the weight of rhyme and not onset.

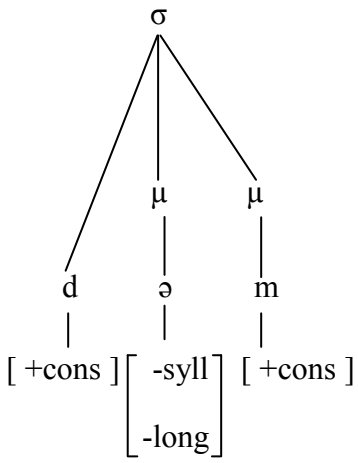
a. Light syllable (L). Light syllable have a short vowel at nucleus with the coda position empty. It is basically an open syllable with a non-branching rhyme. Light syllable have the structure: (C)(C)V. For example: the first syllable in [gʊ.ru] ‘teacher’, [kə.la] ‘art’ and [kə.pətt] ‘quarrelsome’ are light syllables.

kə.la ‘art’

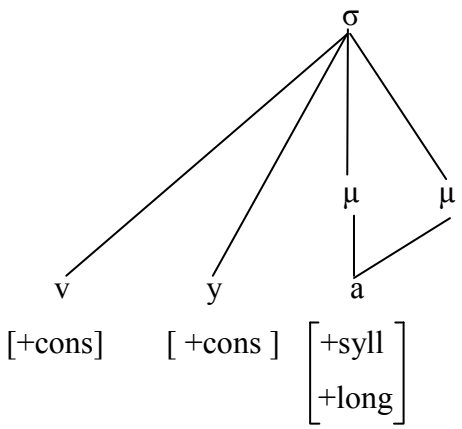


b. Heavy syllable (H). Heavy syllables can have two possible structures. The first one is a branching rhyme, which means that a short vowel is followed by a consonant. It will have the closed structure: (C)(C)VC. For example: [mər] ‘die’ and [dəm] ‘power’ are closed heavy syllables. The second possible heavy syllable will have a branching nucleus with empty coda position which means an open syllable with a long vowel. It will have the structure: (C)(C)V:. For example: [a] ‘come’, [ja] ‘go’, [vya] ‘marriage’ are open heavy syllables. Hence, the representations of /dəm/ and / vya/ are as follows:

dəm ‘power’

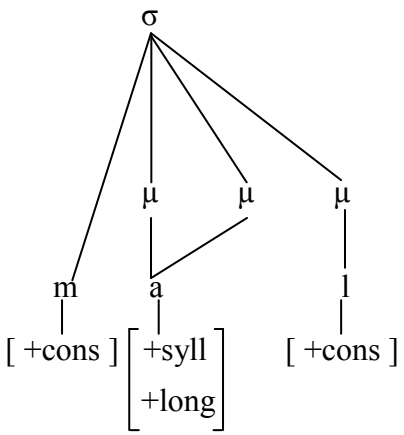


vya ‘marriage’

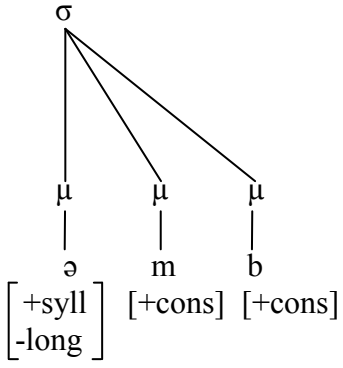


c. Extra-heavy syllable (EH). Extra-heavy syllables can also have two possible structures. The first one is a branching nucleus with a coda, which means that a long vowel is followed by a consonant. It will have the structure: (C)(C)V:C. For example: [jwar] ‘millet’, [mal] ‘commodity’. The second possible extra-heavy syllable will have a nucleus with a branching coda which means that a short vowel is followed by a consonant cluster. It will have the structure: (C)(C)VCC. For example: [əkk^{h}] ‘eye’ and [əmb] ‘mango’.

mal ‘commodity’



əmb ‘mango’



There is a need to study the placement of accent in Punjabi acoustically using the physical correlates of accent, especially to understand the accent placement in words with extra-heavy syllables. Phonologists Fry (1955, 1958), Bolinger (1958), Singh (1972), etc. have taken different parameters as acoustic cues to accent in different languages. Fry (1955) claims that duration is a stronger cue to accent as compared to intensity in English language (p. 767) and Fry (1958) reports that fundamental frequency cue outweighs the duration cue and that intensity is not a very strong cue to accent in English (p. 151). Bolinger (1958) also states that the primary cue to accent in English is pitch prominence and duration is also a cue to accent, however, intensity is not a cue to accent (p. 149). According to Kalra (1982), Singh (1963) claims that the accent in Punjabi is determined by vowel pitch and his work is supported with experimental analysis (p. 47). Joshi (1972, 1973) looks at accent in relation with pitch. Bhatia (1993) proposes that pitch and length of the vowel are phonetic correlates of accent in Punjabi (p. 343). According to Pierrehumbert (1980) and Ladd (1996), f0 movements are direct correlates of pitch accent. According to Ortega-Llebaria and Prieto (2010), f0 is the least debatable correlate of accent (p. 54). Zuraiq and Sereno (2007), O'Halpin (2009) and Quam and Swingley (2014), have claimed that amplitude is a cue to accent in different languages. O'Halpin (2009) explains that amplitude and duration together are a strong cue to stress (p. 286). Zuraiq and Sereno (2007) has used four cues to study stress, three of which are duration, amplitude and f0 (p. 829). Quam and Swingley (2014) show that amplitude is an important cue to stress (p. 85).

Pitch and loudness determine the quality of speech sound. Fundamental frequency and amplitude are their respective controls which have a one-to-one correspondence with pitch and loudness. The parameters used for studying accent in Punjabi are defined in chapter 3.

The present work aims at validating its findings with respect to the accent placement rules given by Gargesh (1999) and intends to understand the complete picture by looking at the placement of accent in words with extra-heavy ultimate syllables quantitatively, by using acoustic measures. Intensity turns out not to be a very

important correlate of accent in most languages, however it seems that amplitude could be a cue to it.

To examine the acoustic realization of accent in Punjabi, an experiment comparing accented vs non-accented rhyme of the same weights with respect to duration, f0 and maximum amplitude was conducted. In order to control background factors, same number of words with open syllables, sonorant and voiced stops in rhyme were selected in each group. The findings of the experiment will be helpful in determining the relation of the accent with- weight of syllable, and their position in a word.

4.1.1. Results

An experiment comparing syllables of different weights in accented vs non-accented environment was conducted. The number of each type of syllable (monosyllabic, bisyllabic and trisyllabic) is same in both groups. Also, the number of open syllables or syllables with sonorant or voiced stops in coda position is kept same. Variable 1 in the table given below is accented syllables and variable 2 is for non-accented syllables. The p-value shows that there is significant different in the f0 of the two groups.

	Variable 1	***Variable 2***
Mean	110.8681818	166.4773
Variance	202.2109564	748.0202
Observations	50	50
Hypothesized Mean Difference	0	
df	15	
t Stat	-5.983117123	
P(T<=t) one-tail	1.25402E-05	
t Critical one-tail	1.753050325	
P(T<=t) two-tail	2.50803E-05	
t Critical two-tail	2.131449536	

The results for different syllable weights are discussed below with examples.

4.1.1.1. Bisyllabics with light or heavy syllables

Let us look at the bisyllabic words given below.

Bisyllabic Words with light or heavy syllables	
Word	Meaning
ˈge.ɖi	roam
ˈkəl.la	alone
ˈjo.ɖa	pair
ˈka.gəj	paper
ˈkʰəb.ba	left handed
ˈə.gəm	unapproachable
ˈgʊ.ru	teacher
ˈke.la	banana

It is observed that all the words in the above table have accent on the penultimate syllable. One must observe that the accent is on the penultimate syllable whenever the ultimate and the penultimate syllables are light or heavy. The comparative acoustic measurements for the words with heavy syllables in accented and non-accented contexts are given below.

Table 2: Acoustic measurements for Heavy syllables

Syllable type	**Duration of the rhyme**	**f0 of the rhyme**	**Maximum amplitude of the rhyme**
Accented	148.7 ms	132.2 Hz	0.6904 Pa
Non-accented	99.4 ms	145.1 Hz	0.5069 Pa
Difference in accented vs non-accented	49.3 ms	-12.9 Hz	0.1835 Pa

The mean duration of the heavy rhymes in accented and non-accented syllables are 148.7 ms and 99.4 ms respectively. There is a difference of 49.3 ms in the mean duration of the accented and non-accented heavy syllables. The mean f0 of the rhyme in accented and non-accented syllables are 132.2 Hz and 145.1 Hz respectively. The mean f0 of the non-accented syllable is more than that of the accented syllable by 12.9

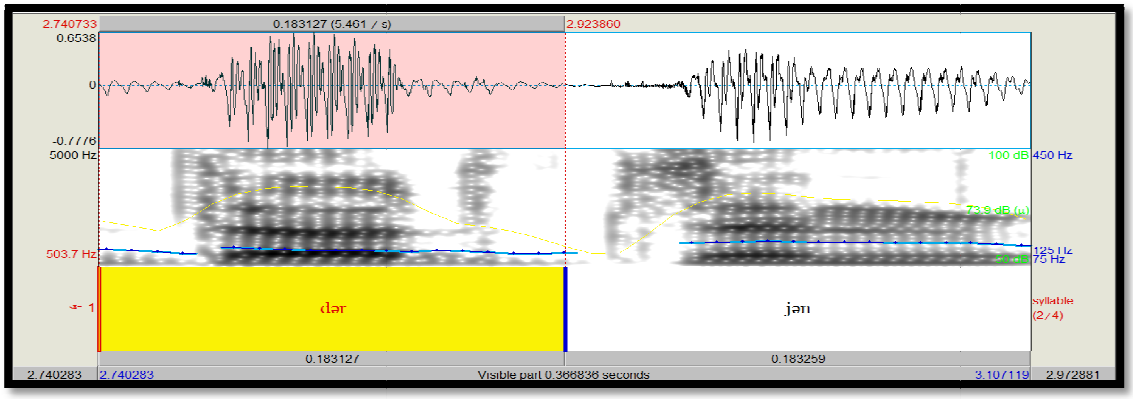
Hz. The mean maximum amplitude of accented heavy syllable is 0.6904 Pa and that of the mean maximum amplitude of non-accented heavy syllable is 0.5069 Pa. The mean maximum amplitude of the heavy accented syllable is higher by 0.1835 Pa.

Let us study spectrogram and acoustic findings for the bisyllabic word [dər.jən] with heavy penultimate and ultimate syllables. The acoustic findings for both the syllables are given in the table below.

Table 3: Acoustic measurements for bisyllabic word [dərjən]

	Syllable type	**Duration of the rhyme**	**f0 of the rhyme**	**Maximum amplitude of the rhyme**
Penultimate syllable [dər]	H	133 ms	125.1 Hz	0.6538 Pa
Ultimate syllable [jən]	H	128 ms	151.9 Hz	0.4413 Pa

The duration of both the syllables in the bisyllabic word [ˈdər.jən] is almost the same (138 ms for penultimate and 128 ms for ultimate syllable) as both the syllables are closed heavy syllables. However the pitch and amplitude differences are evident. The f0 of ultimate syllable (151.9 Hz) is about 27 Hz more than the f0 of the penultimate syllable (125.1 Hz). The maximum amplitude of the penultimate syllable (0.6538 Pa) is 0.2125 Pa more than the maximum amplitude of the ultimate syllable (0.4413 Hz). The acoustic findings confirm that the accent is on the penultimate syllable in [ˈdər.jən]. The spectogram of the word is shown below.



Spectogram 1: Spectrogram of bisyllabic word [dərjən]

Spectograms are graphic representations of speech sounds' energy patterns. The above spectogram has two parts to it. The topmost part shows the sound waves. These are complex waves showing the vibrations due to difference in air pressure. The second part shows the spectogram which makes the above complex waves into energy patterns called formants of the spectograms that are analyzed to study sounds. The present study is looking at fundamental frequency and amplitude values which can be simply checked on the PRAAT software. The blue line shows fundamental frequency. Using the spectogram, the analysis of sounds becomes more reliable, faster and easier. The syllable tier, lowermost tier in the above spectogram, has the syllable mentioned. The spectogram for monosyllabic, bisyllabic and trisyllabic words will have one, two and three syllables marked respectively. The accented syllable is highlighted in this chapter hence the accented syllables will be in yellow. In the above spectogram, the penultimate syllable is highlighted as it is carrying accent. The pitch diagram below shows the difference in the pitch movements of the two syllables in the word.

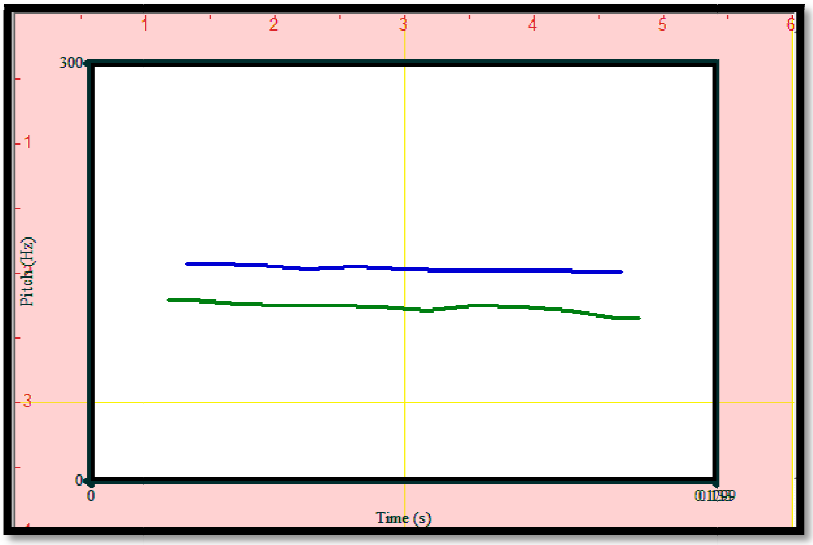
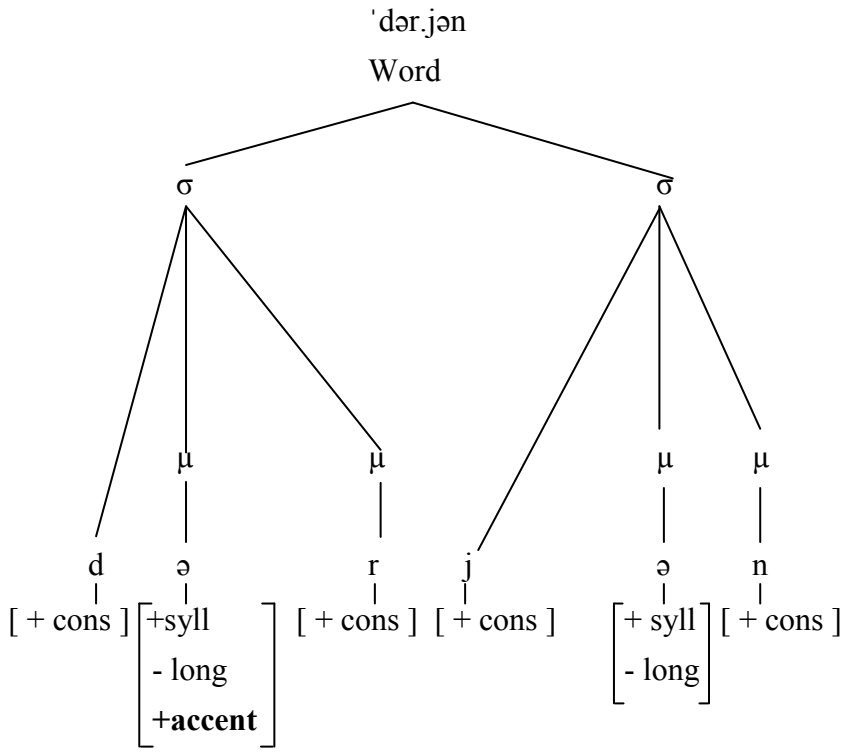


Figure 1: Comparison of pitch movements of the rhymes in bisyllabic word [dərjən]

The above pitch diagram shows that the pitch of the ultimate syllable (in blue) is higher than the pitch of the penultimate syllable (in green) in the word [ˈdər.jən]. The representation below shows the placement of accent on the word.



The above representation shows the placement of accent on the penultimate syllable in the word [ˈdər.jən]. Let us study accent placement in bisyllabic words with extra-heavy syllables.

4.1.1.2. Bisyllabic words with extra-heavy syllables

Bisyllabic Words with extra-heavy syllables	
Word	Meaning
bə.ˈmar	ill
ə.ˈkʰir	last
sə.ˈval	question
dər.ˈbar	court
go.ˈpal	cowboy
ˈtap.man	temperature
ˈkʰan.dan	family
ˈʃan.dar	great

It is observed that the accent is on the ultimate syllable in the first five examples where the ultimate syllable is extra-heavy however, the penultimate syllable is not extra-heavy. The accent is on the penultimate syllable in the last three examples where both the ultimate and the penultimate syllables are extra-heavy.

Let us see comparative acoustic measurements for the words with extra-heavy syllables in accented and non-accented case are given below.

Table 4: Acoustic measurements for Extra-heavy syllables

Syllable type	Duration of the rhyme	f0 of the rhyme	Maximum amplitude of the rhyme
Accented	171.8 ms	134.8 Hz	0.8363 Pa
Non-accented	154.7 ms	146.7 Hz	0.6642 Pa
Difference in accented vs non-accented	17.1 ms	-11.9 Hz	0.1726 Pa

The mean duration of the extra-heavy rhymes in accented and non-accented syllables are 171.8 ms and 154.7 ms respectively. There is a difference of 17.1 ms in the mean duration of the accented and non-accented extra-heavy syllables. The mean f0 of the rhyme in accented and non-accented syllables are 134.8 Hz and 146.7 Hz respectively. The mean f0 of the non-accented syllable is more than that of the accented syllable by 11.9 Hz. The mean maximum amplitude of accented extra-heavy syllable is 0.8363 Pa and that of the mean maximum amplitude of non-accented extra-heavy syllable is 0.6642 Pa. The mean maximum amplitude of the extra-heavy accented syllable is higher by 0.1726 Pa.

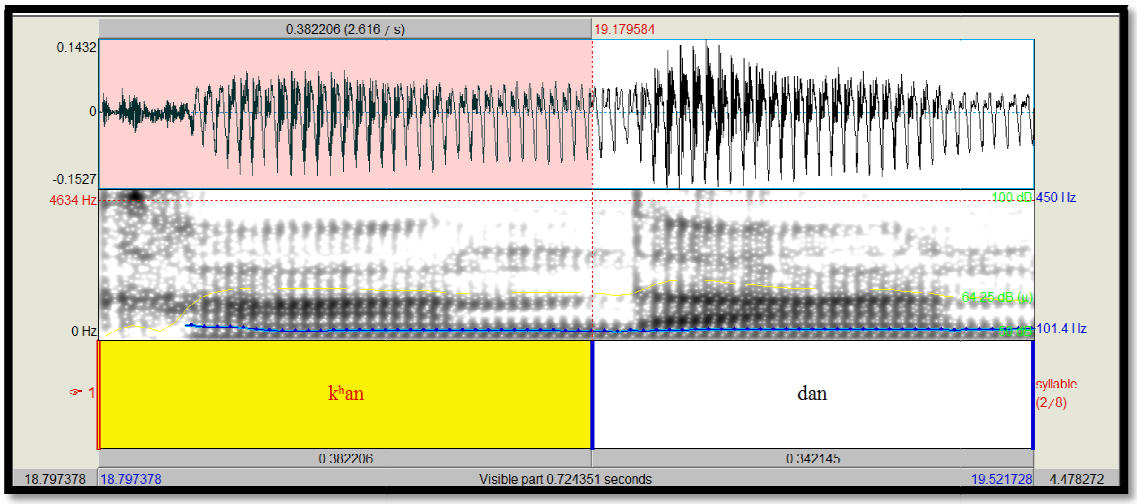
In bisyllabic words, the accent falls on the penultimate syllable, except when the ultimate syllable is extra-heavy. Let us see what happens when both the syllables are extra-heavy such as in [k^{h}andan] ‘family’.

Table 5: Acoustic measurements for bisyllabic word [k^{h}an.dan]

	Syllable type	Duration of the rhyme	f0 of the rhyme	Maximum amplitude of the rhyme
Penultimate syllable	EH	303 ms	100.6 Hz	0.732 Pa
Ultimate syllable	EH	291.4 ms	106.2 Hz	0.7631 Pa

Both the syllables in the above bisyllabic word are extra-heavy, however the duration for the penultimate syllable (303 ms) is 11.6 ms more than the duration for the

ultimate syllable (291.4 ms). The difference in the f0 is very little, 5.6 Hz. The f0 of the ultimate syllable (106.2 Hz) is more than the f0 of the penultimate syllable (100.6 Hz). The maximum amplitude of the ultimate syllable (0.7631 Pa) is more by 0.0311 Hz than the maximum amplitude of the penultimate syllable (0.732 Pa). It seems that the accent is on the penultimate syllable in the bisyllabic word ['kʰan.dan] as the duration and f0 cues suggest so. Let us see the spectogram of the word below.



Spectogram 2: Spectrogram of bisyllabic word [kʰan.dan]

In the above spectogram the penultimate syllable is highlighted as it is carrying accent. The pitch tracings of the two syllables can be looked at in the pitch diagram below.

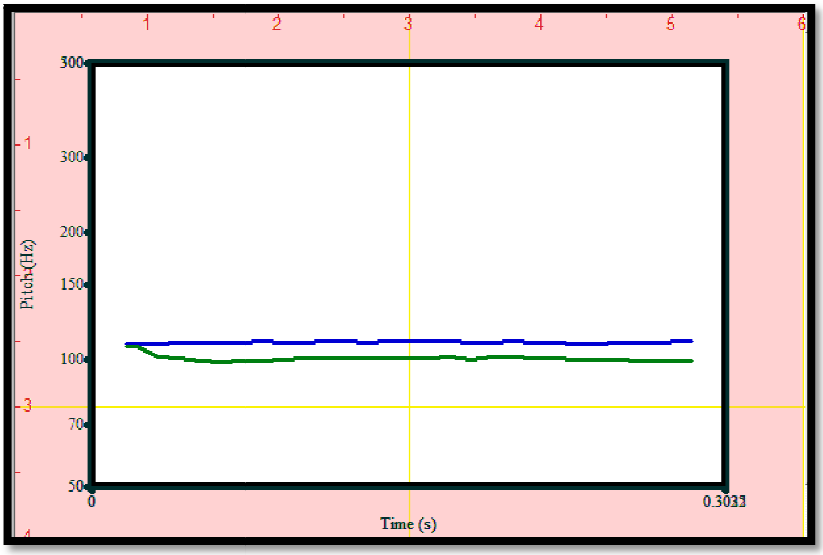
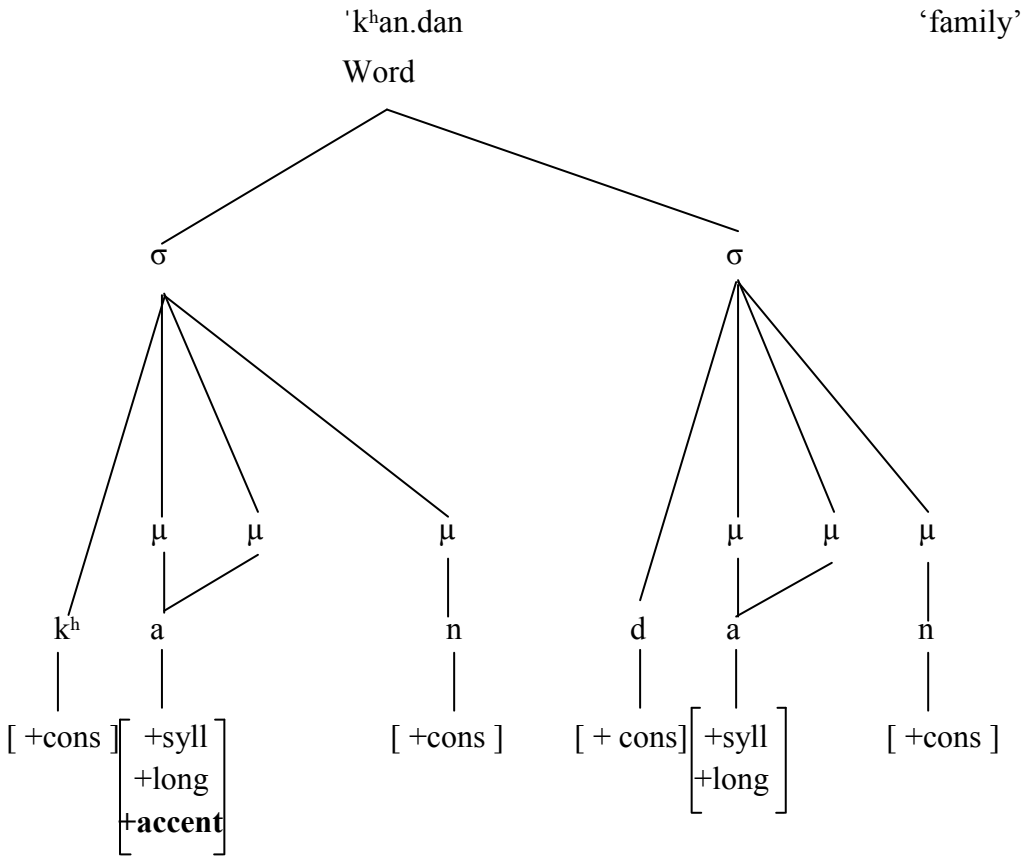


Figure 2: Comparison of pitch movements of the rhymes in bisyllabic word [kʰan.dan]

The pitch diagram above shows the difference in the pitch of the ultimate syllable (in blue) and the penultimate syllable (in green) in the bisyllabic word [ˈkʰan.dan]. Let us see the placement of accent in the phonological representation of the word.



The representation above shows the placement of accent on the penultimate syllable in the word [ˈkʰan.dan]. The above findings suggest that the accent falls on the penultimate syllable in bisyllabic word and moves to the ultimate syllable only when it is extra-heavy and the penultimate syllable isn't extra-heavy. It is important to study the placement of accent on trisyllabic words in order to formulate rules for accent placement. Therefore, accent placement on trisyllabic words is studied below.

4.1.1.3. Accent in Trisyllabic Words

Let us see the placement of accent on trisyllabic words with heavy or extra-heavy syllable.

Trisyllabic Words with heavy or extra-heavy penultimate syllable	
Word	Meaning
dɪ.ˈwa.li	festival of lights
ˈgʊr. mʊk.kʰi	from the mouth of the teacher
jʊr.ˈma.na	fine/ penalty
ˈəm.bər.sər	Amritsar
pə.ˈvɪt.tər	pure
fə.ˈla.na	someone

Accent is placed on penultimate syllable in all the above examples w the penultimate syllable is heavy and antepenultimate syllable is light, however in examples where both are heavy such as in [ˈgʊr. mʊk.kʰi], the accent is on the antepenultimate syllable. The examples with light penultimate syllable are given below.

Trisyllabic Words with light penultimate syllable	
Word	Meaning
ˈnaʃ.pə.ti	pear
ˈgəd̪.bə.d̪i	chaos
ˈəs.pə.tal	hospital
ˈuʈ.pə.taŋ	haphazard

The accent is on the antepenultimate in all the above examples where penultimate syllable is light. It is to be noted that the antepenultimate syllable in all the above words is heavy or extra-heavy. Let us see below the placement of accent in examples where both the penultimate and antepenultimate syllables are light. The comparative acoustic measurements for the words with light syllables in accented and non-accented context are given below.

Table 6: Acoustic measurements for light syllables

Syllable type	**Mean duration of the rhymes**	**Mean f0 of the rhymes**	**Mean maximum amplitude of the rhymes**
Accented	68 ms	129.3 Hz	0.6606 Pa
Non-accented	40.7 ms	139.2 Hz	0.4642 Pa
Difference in accented vs non-accented	28.1 ms	-9.9 Hz	0.1964 Pa

The mean duration of the light rhymes in accented and non-accented syllables are 68 ms and 40.7 ms respectively. There is a difference of 28.1 ms in the mean duration of

the accented and non-accented light syllables. The mean f0 of the rhyme in accented and non-accented syllables are 129.3 Hz and 139.2 Hz respectively. The mean f0 of the non-accented syllable is more than that of the accented syllable by 9.9 Hz. The mean maximum amplitude of accented light syllable is 0.6606 Pa and that of the mean maximum amplitude of non-accented light syllable is 0.4642 Pa. The mean maximum amplitude of the light accented syllable is higher by 0.1964 Pa.

4.2 (Re)Accentuation on Affixation

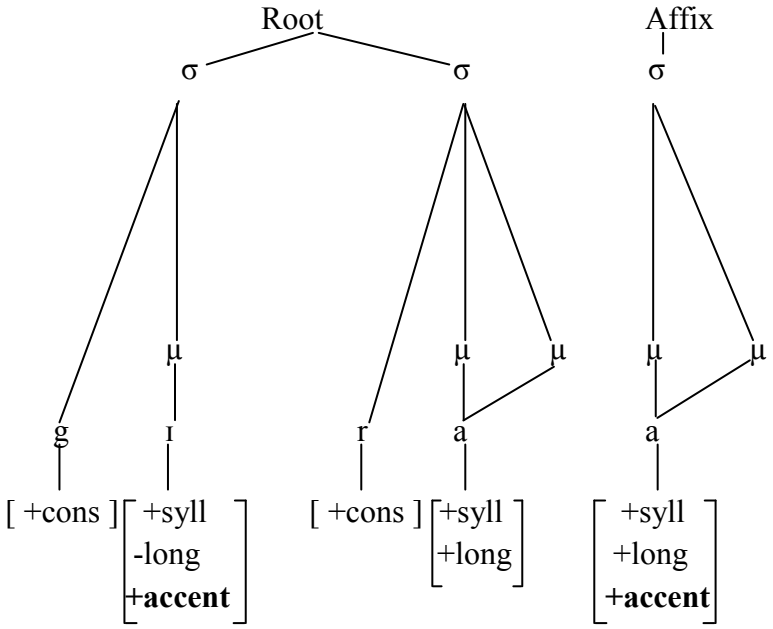
Consider the examples given below in which affixes are added to the root word.

Accent Placement after Resyllabification		
ˈdɪkʰ	dɪ.ˈkʰa.vəʈ	appearance
ˈpa.gəl	pa.ˈgəl.pən	insanity
ˈləʈ	lə.ˈɽa.ku	belligerent
ˈkʰeɭ	kʰɪ.ˈla.ɽi	player
ˈluʈ	lʊ.ˈʈe.ra	thug
ˈsəj	sə.ˈja.wəʈ	decoration
ˈseʈʰ	se.ˈʈʰa.ɳi	wife of merchant

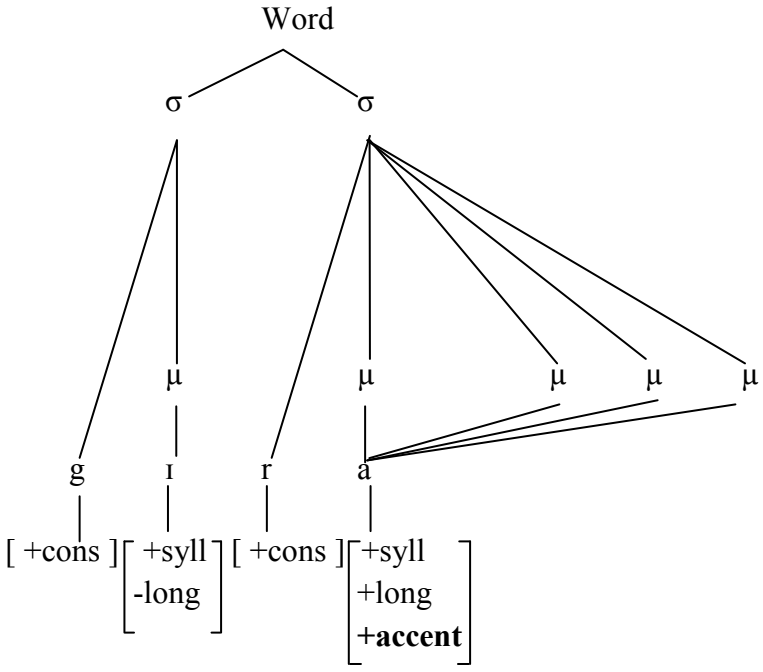
The placement of accent on words containing affixes takes place in two steps. All the morphemes are independently accented and after resyllabification, the rule of accented applies again. Consider the placement of accent in the words [ˈseʈʰ] 'merchant' and [se.ˈʈʰa.ɳi] 'merchant's wife'. Each morpheme gets accent. However, after syllabification, the accent will be observed only on one syllable.

Some scholars have pointed out that imperatives and participles are exceptions to the above rules (Tolstaya, 1981), as the accent falls on the ultimate syllable in words [kaˈro] 'do!' and samaˈjhā 'having suggested' (p. 11-12). It has also pointed that the words with suffixes like [–va.la] (eg. [lɪ.kəɳ.va.ˈla] 'writer'), [-har(a)] (eg. [sɪr.jən.ˈhar] 'creator'), [-dar], [-kar] (eg. [cɪt.tər.ˈkar] 'artist'), [-van], etc also have accent on the ultimate syllable. Kalra (1982) has given 'grammatical stress placement rule' according to which the causative or imperative suffix get the accent (p. 58). Bhatia (1993) also proposed the same (p. 343). Gargesh (1999) points out that

imperatives are a result of a heavy suffix [–a] being added to the root word. In the above examples, the ultimate syllable is heavy, so when a heavy suffix is added to it, the ultimate syllable becomes extra-heavy. Therefore, the accent is on the ultimate syllable. The derivation of imperative [gɪra] 'to make fall' from [gɪra] 'fallen' is given below which explains the above point:



gɪra 'to make fall'



4.3 Generalizations

It is evident from the above data that duration, f0 and maximum amplitude are cues to accent in Punjabi. The accented syllables have a tone target which varies from language to language. The accented syllables in Punjabi have systematically lower f0 than non-accented syllables which means that accented syllables have a pitch accent L* in Punjabi. These results suggest that accented syllable in Punjabi might be systematically having lower f0 values and are longer than the corresponding non-accented syllables. The maximum amplitude of the accented syllable is found to be higher than the maximum amplitude of the non-accented syllable in most cases.

The findings of the present work reveal that the rules of accentuation proposed by Gargesh (1999) need to be restated as he did not give examples to show accent placement if both syllables are extra-heavy in bisyllabic words. The third rule has been modified since accent is observed on antepenultimate when all the three syllables are heavy in trisyllabic words. The fourth rule stated below is proposed by the present study for Punjabi. The rules of accentuation are below:

Rules of accentuation

a) All monosyllabic words are accented.

b) In bisyllabic words, the accent is on penultimate syllable. It shifts to ultimate only if the ultimate syllable is extra-heavy and penultimate isn't.

c) In trisyllabic words (and also in polysyllabic words), the accent is on penultimate syllable. It shifts to antepenultimate only if the penultimate is light and antepenultimate isn't or when the antepenultimate, penultimate and ultimate syllables are heavy.

d) The rules of accentuation apply again to the word after resyllabification.

4.4 Conclusion

In this chapter, the rules for the placement of accent for Punjabi are supported with experimental findings. It is seen that duration, f0 and maximum amplitude are cues to accent in Punjabi. The accented syllables in Punjabi have systematically lower f0 than

non-accented syllables which means that accented syllables have a pitch accent L* in Punjabi. These results suggest that accented syllable in Punjabi have systematically lower f0 values and are longer than the corresponding non-accented syllables.

The rules of accent placement posited in the chapter account for the mono-, bi- and tri-syllabic words correctly. It is noted that the notion of extra-heavy syllables is very important in understanding the placement of accent in Punjabi. It is a very interesting accent pattern because of its multi-layered hierarchy of weight. The rules are also able to account for accentuation in words with affixes. These prosodic elements apply to and interact with the phonological-morphological derivation of words simultaneously. These prosodic elements also help in better understanding of the phonological problems in Punjabi. We shall see in the next two chapters that a better understanding of the concept of accent will help in solving phonological problems like the placement of tones and deletion of schwa.

CHAPTER 5

ASPECTS OF PUNJABI PHONOLOGY II

Tones in Punjabi have a special status. In the present chapter, an attempt will be made to understand the relation between orthographically present voiced aspirated sounds and tones observed in the spoken form in the first section. The rules for predicting the type and place of tone will also be formulated. The less studied, yet an important prosodic feature, intonation will be looked at in the second section of the current chapter.

5.1. Tones in Relation to Aspiration

Tones in Punjabi are very different from tones in Chinese, and several other tonal languages. A survey of the literature shows that the scholars have recognized the importance of tones in Punjabi, however, varied accounts have been given for the types of tones present in Punjabi and its placement (explained below). The present work will focus on understanding the relation between the orthographically present voiced aspirated sounds in words and the tones attested in spoken variety of Punjabi. The rules for predicting the type and placement of tone will also be given.

Scholars have given different accounts to explain the presence of tones in relation to aspiration in Punjabi language. Most scholars have reported that there is a relation between voiced aspirated sounds and tones, hence they have related the type of tone developed with the position of voiced aspirated sounds in the word. Jain (1934) and Sandhu (1972) propose that the voiced aspirated sounds lose aspiration and voicing (in word initial position) in Punjabi and that the type of tone observed depends on the position of accented syllable with respect to the voiced aspirated sounds. However, According to Bahri (2011), level tones and stress co-exist and voiced aspirated sounds are replaced with a low-rising tone on the syllable (but he doesn't mention what factor determines the loss of voice feature). Moreover, he states that high-falling tone (caused by presence of h in syllable medial or final position) is phonemic and is always stressed and that low-rising tone is the substitute for voiced aspirated sounds

(Bahri, 2011, p. 17-18). Haudricourt (1971) and Kalra (1982) have also given diverse accounts to explain the problem of tones in Punjabi. Haudricourt (1971) proposes that consonantal mutation is responsible for the presence of tones in Punjabi. The glottalised consonants lost their glottalisation and became voiced over a period of time. These voiced consonants were marked and gradually became voiceless and acquired aspiration (Haudricourt, 1971, p. 1-2). Kalra (1982) considers aspiration to act as pitch depressors. They lower the pitch of neighboring vowel and this lowering of pitch is assimilated on the accented vowel thereby developing tone on the stressed vowel. The process of deaspiration can take place thereafter as the pitch depressing features have been retained on the vowel (p. 288). Ohala (1991) claims that voiced aspirated consonants lost aspiration leading to low tone on following vowel or high tone on preceding vowel (p. 113).

The transcription in the discussion below are used as in the work mentioned here. Gargesh (1999) and Singh (2004) have pointed out the presence of three types of tones in Punjabi- high, low, and level (p. 71). He has also used the terms rising and falling for high and low tones respectively. According to Singh (2004), when the Hindi cognates have voiced aspirated sounds in word initial positions, falling tone is observed in Punjabi word, eg. [pòcal] 'earthquake', [tòl] 'drum', resulting in devoicing and deaspiration. When the Hindi cognates have voiced aspirated consonants in non-word initial syllable onset positions, falling tone is observed with deaspiration, eg. [jɔjàr] 'fighter', [kəndàr] 'name of a place'. When the Hindi cognates have voiced aspirated sounds in the coda position, high tone and deaspiration is observed in Punjabi, eg. [bód] 'wisdom', [múd] 'stupid' (Singh, 2004, p. 71-82).

Bahl (1956) reports four types of tones in Awankari dialect of Lahanda (Western Punjabi)- falling, high, low rising and mid tone. Bahl states that low rising tones are found only in a couple of words as it is "concomitant of the medial h", eg. [vərìna] 'death anniversary', high tone is considered a kind of falling tone and mid tone is observed in the absence of any other tone, eg. [va] 'wind'. He reports that the tonal contrast can occur on any syllable in bisyllabic words and does not talk about tonal contrast on words with more than two syllables (Bahl, 1956, 31). Malik (1995) also

observes the presence of four tones in Punjabi- rising, falling, rising-falling and zero-glide. The level tone is zeroed or unmarked and high falling tone is present in vowels preceding voiced aspirated sounds whereas low rising tone (represented as ˂) is present in words like [t˂o] 'wash', [k˂əbra] 'feel perplexed' (p. 86-87).

Although Bahl (1956) and Malik (1995) have reported four tones in Punjabi, there are scholars who have claimed the presence of three tones in Punjabi. Bahl (1957) has reported presence of Even, Falling and Rising tones in Majhi spoken in Amritsar, which contrast with each other phonemically (p. 139). Each word has only tone and can occur on any syllable in bisyllabic words (doesn't talk about words with more than two syllables). Bahri (1969) has claimed that tones are phonemic (p. 99) and has described the type of tone- low, high or level tone in Dogri on the basis of type of syllable and vowel kind (p. 99-107). Tolstaya (1981) has proposed that there are three tones in Punjabi- low, high and even. The low tone is observed if there is an /h/ in the word or if the voiced aspirated sounds precede the 'tone bearing' syllables', which also results in devoicing and deaspiration and /h/ is not pronounced, eg. [kòra] 'horse', however, high tone is observed if the voiced aspirated sounds or /h/ follow the tone bearing vowel, resulting in only deaspiration eg. [kóra] 'leprous' and even tone is marked on stressed syllables which do not have /h/ or voiced aspirated sounds (Tolstaya, 1989, p. 12). Dulai (1989) has also proposed that there are three tones in Punjabi- high, low and mid (p. 31-33). According to Dulai (1989), high tones can occur in any position (initial, medial or final), eg. [cá] 'tea', [édda] 'half', [dód] 'milk', and the syllables with high tones have lesser duration that the syllables of other two types of tone. Low tone occurs in medial and final positions and the syllables with low tone are claimed to be longer than the syllable with the other two types of tone, eg. [pài] 'brother', [kà] 'grass' and mid tones are unmarked in transcription as in [bar] 'uncultivated land', [kıl] 'a nail'. He has not listed any rules for predicting the placement or type of tones in Punjabi. Gill and Gleason (2013) proposes presence of three tones in Punjabi- high (eg. [jələ̃dər] 'Jalandhar'), normal (eg. [əmrıtsər] 'Amritsar') and low (eg. [lʊdıàne] 'Ludhiana'). The tone is generally on the first syllable (eg. [pèjũga] 'will send', [cá] 'tea') and sometimes on the second syllable (eg. [pərà] 'fill', [wəgá] 'throw') (p. 18).

Luthra and Singh (2012) and Arun (1997) have also reported three tones in Punjabi and they have also stated that the syllable bearing accent carries tone too. Most of the above mentioned studies have listed the various environments in which the different types of tone occur, however, they have not made any generalization of the basis of the examples given. Bhatia (1993), on the other hand, proposes that the low tone always rests on the accent syllable (eg. [pəndár] 'storage') however, high tone doesn't necessarily follow this pattern in some dialects like Rathi and Puadhi (eg. [prə́bʊ] 'God'). He also states that if the tones are 'morphologized' then its placement is unpredictable, eg. [pəɽà] 'study + causative'. Level tone is present on syllables that have neither low nor high tone and is not marked (Bhatia, 1993, p. 344).

Gargesh (1999) gives rules for placement of accent in Punjabi and claims that the tone is present on the accented syllable. If the voiced aspirated sounds precede the accented vowel, it gets a low tone and deaspiration (and devoicing, if word-initial) is observed, eg. [tèrəm] 'religion', [ʊdàr] 'loan'. If the voiced aspirated sounds follow the accented vowel, it gets a high tone and deaspiration is observed, eg. [jələ́ndər] 'Jalandhar', [və́dıya] 'good'. Kanwal and Ritchard (2015) conducted an experiment and reported to have found three tones in Punjabi- low, high and level. Falling tone (falling pitch) is observed in word-initial position leading to devoicing and deaspiration of historically found voiced aspirated sounds. Voiced unaspirated sounds are found word medially, but it does not report any significant pitch difference in word medial positions

Bowden (2012) also claims that the placement and type of tones in Punjabi are predictable and that it depends on the following factors- weight of the syllable, historically voiced aspirated sounds and its position in a word. She states that rising tone is observed on vowels preceding historically voiced aspirated sounds and falling tone is observed on vowels following historically voiced aspirated consonants (p. 24). Kaul (2017) has used acoustic means to study tones in Punjabi, however she didn't show any spectograms or mention the parameters she took into account. Also, the work is done on Dogri dialect and hasn't taken into account the concept of syllable or accent placement. No defined rules for tone placement are given.

Tones can be observed in spoken Punjabi and unlike other tonal languages, not every syllable has a contrastive form in Punjabi, hence it would be appropriate to say that Punjabi has two tones: rising, and falling. Pike (1956) claims that there are few examples in Punjabi from which tones appear phonemic, therefore, tones are not phonemic in Punjabi (as mentioned in Bowden, 2012, p. 5). Some of the examples of the same are given below.

Table 7: List of words with different tones (used in sentences)

	Falling Tone	**No tone**	**Rising Tone**
koɽa	horse	whip	leper
	kòɽa kɪtt^{h}e gya?	koɽa na mar	kóɽa a gya
poli	thorny plant	soft	guileless (f.)
	ɛ poli da poda e	o poli gəl kərda si	o poli kʊɖi
ʈoɳa	fumble	charm	to carry
	sara nəmək ʈoɳa kər ger dɪtta	onde ʊtte kisi ne ʈoɳa kər ditta si	ohnu səman ʈoɳa paiga
cola	dainty	cloak	knapsack
	k^{h}et cola honda si	pəndət bəsənti cola paya si	səman da cola cʊkko
ca	peep	enthusiasm	tea
	kʊdi ne ca kərke ohnu dəra dɪtta	ohnu k^{h}elən di bədi ca si	kʊdi nu ca pila
kəɽi	wrist watch	ring of chain	curry made of curd
	teri kəɽi icc ki tɛm e?	es kəɽi nu onde nal joɽ do	kəɽi svad bəni e

[Note: In the present work, [`] and [´] would be used to represent falling and rising tones respectively.]

Given below is the pitch diagram showing pitch movements on the word [ca] with three different tones on it.

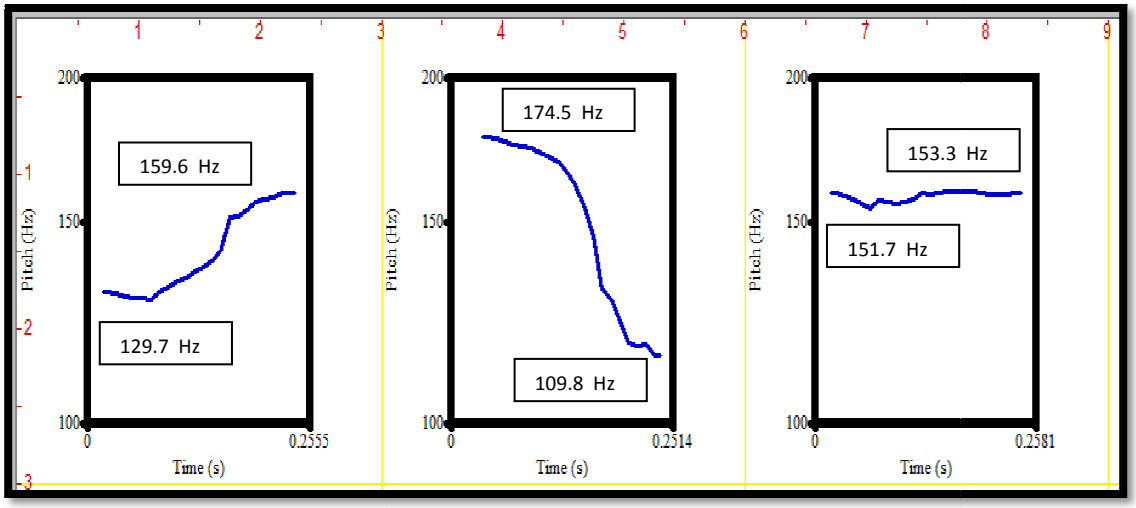


Figure 3: Pitch movement on [cá], [cà] and [ca] showing the placement of different tones- rising, falling and no tone

The figures above show that the tones in Punjabi do not have values higher or lower than accent to show high or low tone. Instead, the tones are either rising or falling (as can be seen in the pitch diagrams above). Hence the terms 'high' and 'low' tone used by most scholars for Punjabi is replaced by 'rising' and 'falling' tones since it is resolved by spectograms of the words with tones on them. The above pitch diagrams show placement of rising, falling and no tone on the same word 'ca' in Punjabi. The maximum and minimum pitch are mentioned in each pitch diagram. There is a difference of 29.9 Hz in the pitch on [cá] as the pitch has increased from 129.7 Hz to 159.6 Hz. The sharp rise in pitch can also be observed in the pitch diagram shown above, hence there is rising tone. In the word [cà], pitch has fallen from 174.5 Hz to 109.8 Hz, thus falling tone is observed on it, as can be seen in the pitch diagram. However, in the word [ca] there is no tone, hence the difference in pitch is very little i.e. 1.6 Hz. Since there is no reportable difference found in the pitch values of [ca], it is proposed that there is only accent on the word and no tone is there. The above pitch diagram hence shows the difference in the pitch diagram of accent and tones. The tones are rising or falling whereas the pitch of accent is neither increasing nor decreasing considerably. Hence, the present work believes that Punjabi has only two tones- rising and falling tone. The examples which show tone is phonemic are limited, hence the present work will focus on figuring out the placement and type of tone on words and their relation with voiced aspirated sounds.

The placement of tones is predictable in Punjabi. The placement and type of tones can be determined from the placement of accent and historically present voiced aspirated

sounds in the word. Tones have a synchronic relation with accent and a diachronic relation with voiced aspirated sounds, observed in its orthographic script. For example, in [ṭài] 'two and a half', and [jíb] 'tongue', tone is occurring at the accented syllable only.

There is a strange relation between voiced aspirated sounds and tones in Punjabi. There are no voiced aspirated sounds found in spoken Punjabi. Instead, it is noted that the tone is present on all those words where the voiced aspirated sounds are used in orthography. This indicates that voiced aspirated sounds were used in the spoken form when the orthography was developed for the language. The study of tones in Punjabi would be explained in the context of its orthography. It is to be noted here that tones are also observed in some words where there are no voiced aspirated sounds in orthography, which will also be discussed in the present section. An experiment comparing rising and falling tones was conducted to study tones acoustically and pitch diagrams were plotted to see pitch movements.

5.1.1. Results

Two types of tones are attested on words in Punjabi- rising and falling. The presence of tone on words in Punjabi is observed with deaspiration of the voiced aspirated sounds. In some words, devoicing also takes place.

In order to study whether there is significant difference in the f0 values of the words, ANOVA test was done. The minimum and maximum f0 values of the rhymes of syllables with tone were compared using ANOVA test. The findings of the test are given below:

ANOVA						
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	3271.143	1	3271.142857	8.884376617	0.011472	4.747225
Within Groups	4418.286	12	368.1904762			
Total	7689.429	13				

The above measurements show that the p-value (0.011472) shows statistically significant difference for the tonal variations in Punjabi language. The descriptive statistical analysis of the minimum and maximum f0 for tonal variation is also given below. Column 1 and

column 2 below show the descriptive statistical analysis for minimum and maximum f0 values respectively for rising tone in Punjabi.

Column 1			*Column 2*	
Mean	130.2857143		**Mean**	160.8571429
Standard Error	6.72845516		**Standard Error**	7.741134934
Median	127		**Median**	169
Mode	#N/A		**Mode**	169
Standard Deviation	17.80181906		**Standard Deviation**	20.4811179
Sample Variance	316.9047619		**Sample Variance**	419.4761905
Kurtosis	-0.892938424		**Kurtosis**	1.148644925
Skewness	0.570939214		**Skewness**	-1.072794401
Range	48		**Range**	62
Minimum	109		**Minimum**	123
Maximum	157		**Maximum**	185
Sum	912		**Sum**	1126
Count	7		**Count**	7

The mean value for minimum f0 in words with rising tone is 130.28 Hz whereas the mean value for maximum f0 in words with falling tone is 160.86 Hz, thus there is a difference of 30.58 Hz in the minimum and maximum f0 values.

Columns 3 and 4 below show the descriptive statistical values for minimum and maximum f0 respectively in words with falling tone.

Column 3			*Column 4*	
Mean	126.1428571		**Mean**	186.4285714
Standard Error	6.135100307		**Standard Error**	7.12091869
Median	123		**Median**	182
Mode	#N/A		**Mode**	#N/A
Standard Deviation	16.23194968		**Standard Deviation**	18.84017996
Sample Variance	263.4761905		**Sample Variance**	354.952381
Kurtosis	-2.020338864		**Kurtosis**	-0.766319929
Skewness	0.20860386		**Skewness**	-0.060702945
Range	40		**Range**	55
Minimum	107		**Minimum**	158
Maximum	147		**Maximum**	213
Sum	883		**Sum**	1305
Count	7		**Count**	7

The mean value for minimum f0 in words with falling tone is 126.14 Hz whereas the mean value for maximum f0 in words with falling tone is 186.43 Hz, thus there is a difference of 60.29 Hz in the minimum and maximum f0 values on an average in words with falling tone.

Let us look at the acoustic findings below to study tones in Punjabi.

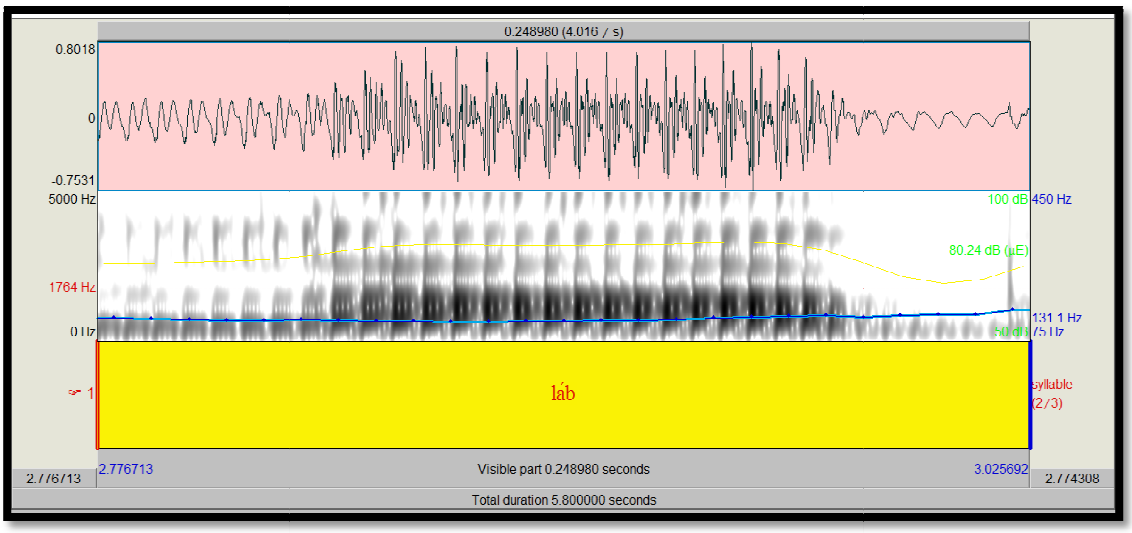
5.1.1.1 Rising Tone observed with Deaspiration

Let us look at some examples with rising tone on them.

Rising Tone				
Sanskrit	Prakrit	Orthography (Gurmukhi)	Spoken Variety of Eastern Punjabi	Gloss
labʰə	labʰə	labʰ	láb	profit
jibbʰə	jɪbbʰa	jibʰ	jíb	tongue
dʊgdʰə	dʊddʰə	dudʰ	dʊ́d	milk
səmʊjʰə	səmbʊjjʰəi	səməjʰ	sə́məj	understanding

(Prakrit and Sanskrit vocabulary has been taken from *A Comparative Dictionary of the Indo—Aryan Languages* by Turner)

Rising tone is observed on the above words in Punjabi and deaspiration of the voiced aspirated sounds present in orthography or in Prakrit words is observed, however no devoicing is observed. Let us see the placement of rising tone on the word [láb] below.



Spectogram 3: Spectrogram of [láb]

In the above spectogram the syllable carrying tone is highlighted. The pitch diagram below shows pitch movement for rising tone on the above word.

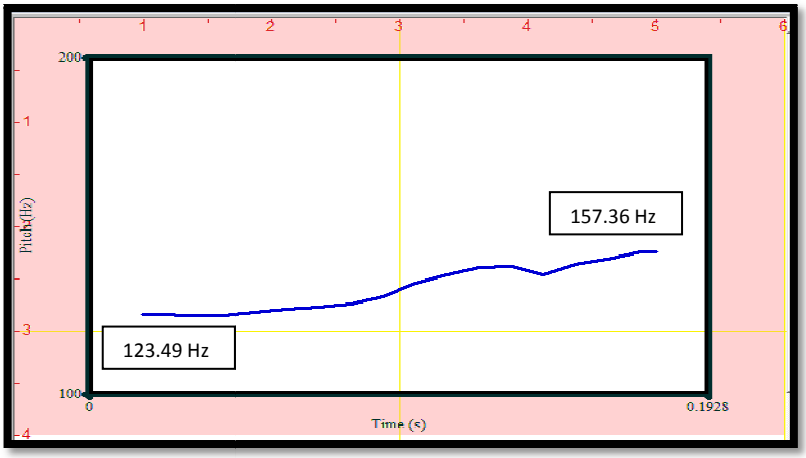
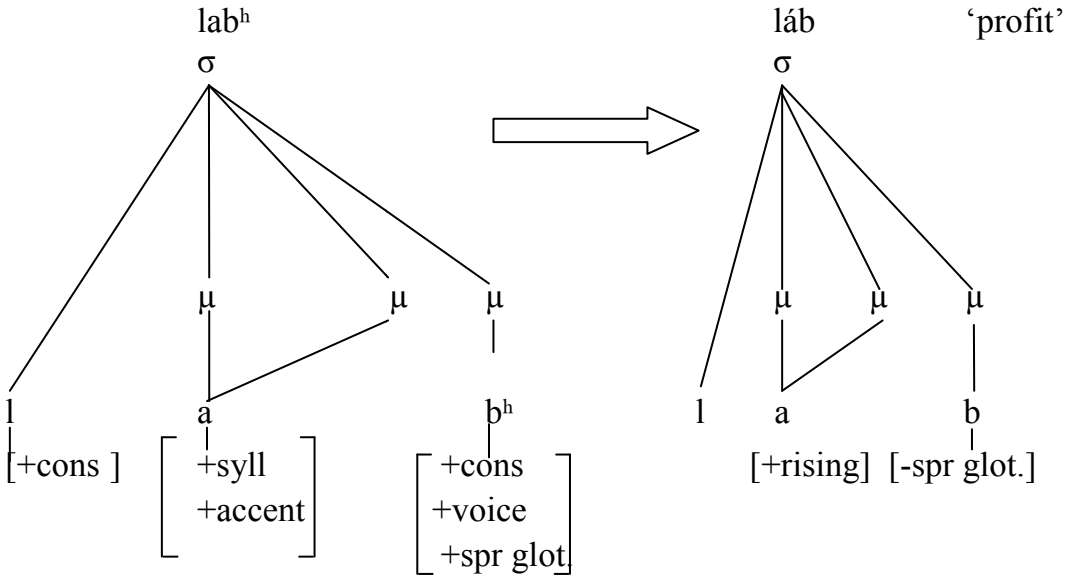


Figure 4: Pitch movement showing rising tone on [láb]

The above pitch diagram shows that the tone on the word [láb] is rising from 123.49 Hz to 157.36 Hz in a duration of 192.8 ms. Thus, there is rising tone on the word [láb]. The maximum and minimum pitch are also marked in the above pitch diagram. The representation below shows the placement of tone on the word.



The above representations show that there was a voiced aspirated sound in the word [láb], as per orthography. However, in the spoken variety there is no voiced aspirated sound, instead rising tone is observed on the word. From the above examples, it can

be deduced that rising tone is observed on the accented syllable and deaspiration is observed but not devoicing. It is to be noted here that the voiced aspirated sound follows the accented vowel.

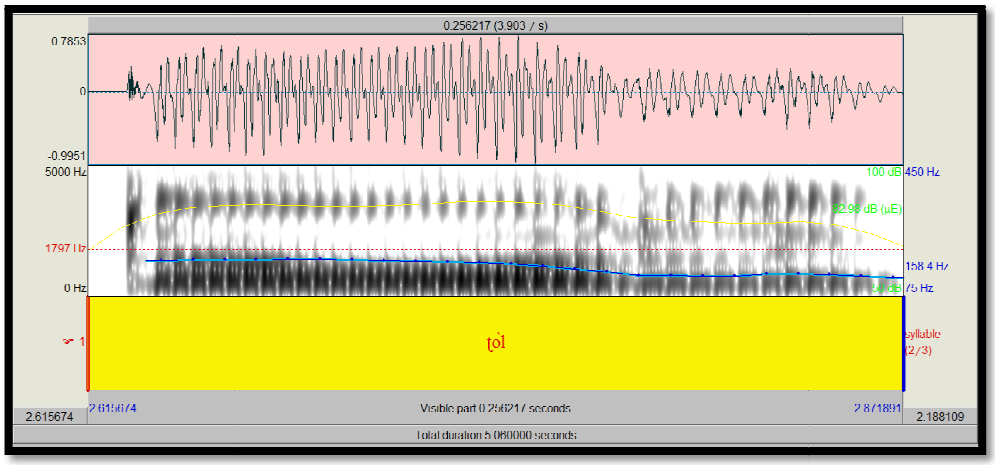
5.1.1.2 Falling Tone observed with Deaspiration and Devoicing

Let us now study the placement of falling tones in Punjabi which is observed with both deaspiration and devoicing of the voiced aspirated consonants. It is important to understand the placement of voiced aspirated sounds in these words to draw valid generalizations. Examples of words with falling tone are given below:

Falling Tone with deaspiration and devoicing				
Sanskrit	Prakrit	Orthography (Gurmukhi)	Spoken Variety of Eastern Punjabi	Gloss
gʰoɽo	gʰoɖə	gʰoɖa	kòɖa	horse
ɖʰolki	ɖʰolə	ɖʰol	ʈòl	drum
bʰəu	bʰəyə	bʰəy	pè	fear

(Prakrit vocabulary has been taken from *A Comparative Dictionary of the Indo—Aryan Languages* by Turner)

Falling tone is observed on the above examples along with deaspiration and devoicing of the voiced aspirated sounds in the words present in Prakrit form or orthography. Let us study the acoustic findings of the words with falling tone on them.



Spectogram 4: Spectrogram of [ʈòl]

In the above spectogram the syllable carrying tone is highlighted. The pitch diagram below shows falling tone on the word.

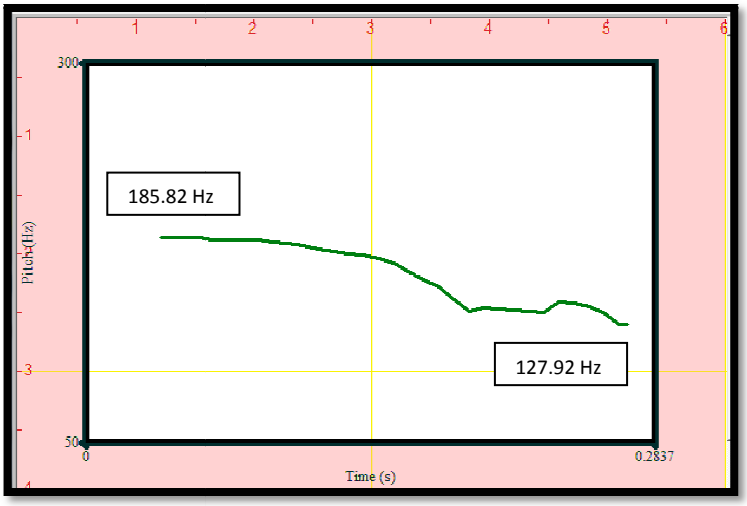
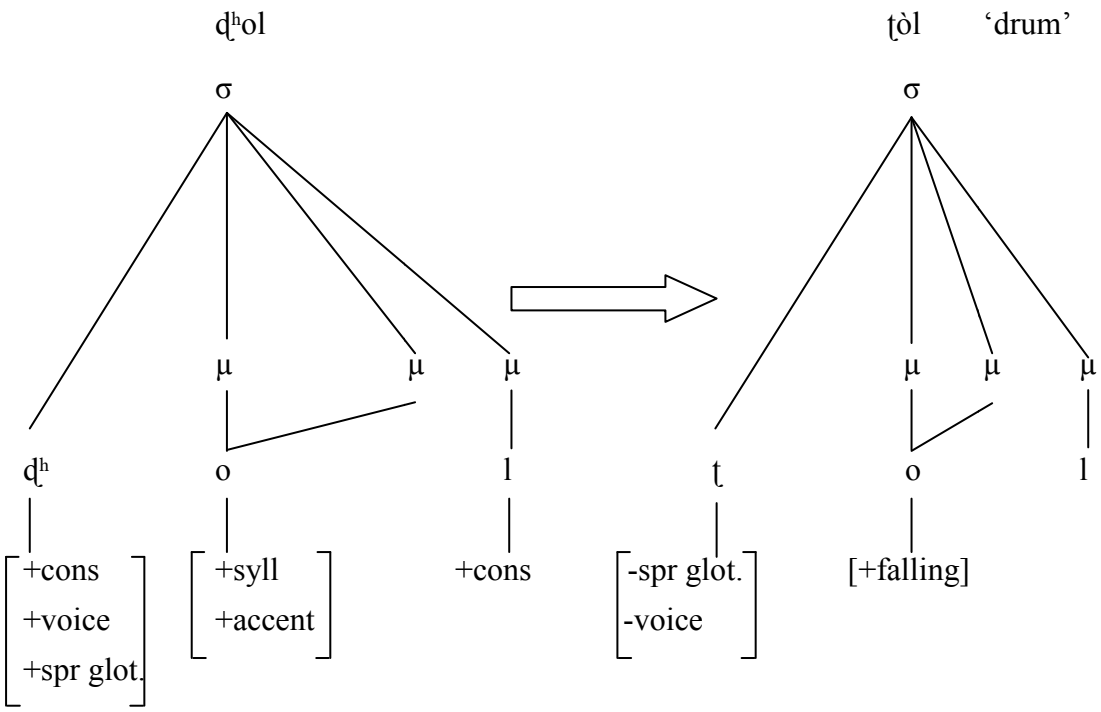


Figure 5: Pitch movement showing falling tone on [ʈòl]

The above pitch findings show that the pitch has fallen from 185.82 Hz to 127.92 Hz in 234.7 ms, thereby developing falling tone on the word [ʈòl]. The representation below shows the placement of falling tone on the word.



The above representations show that there is a voiced aspirated sound in the orthography of the word [ʈòl], however in the spoken variety, a voiceless unaspirated sound with falling tone is present. From the data above, it is observed that a falling tone is developed on accented syllable which resulted in devoicing and deaspiration of

the voiced aspirated consonant. In these examples, the voiced aspirated sound is preceding the accented syllable and is at word-initial position.

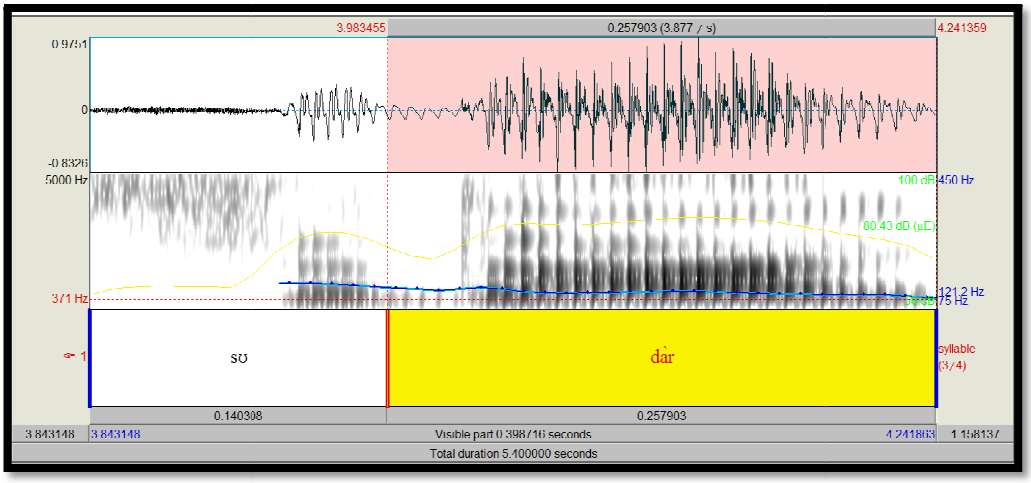
5.1.1.3 Falling Tone observed with Deaspiration but no Devoicing

In the previous section, we have seen that the presence of falling tone results in both deaspiration and devoicing. However, it is not the case with all the words with falling tone in Punjabi. We will see that there is falling tone in examples given below where deaspiration is observed but devoicing is not observed. The reason for the same can be explained using the concept of syllable structure.

Falling Tone with deaspiration but no devoicing				
Sanskrit	Prakrit	Orthography (Gurmukhi)	Spoken Variety of Eastern Punjabi	Gloss
gə̃bʰirʊ	gəmbʰirə	gəmbʰir	gəmbìr	serious
səmʊjʰə	sʊjjʰəɳəya	səmjʰaya	səmjàya	explained
sʊdʰarəɳʊ	sʊddʰərə	sʊdʰar	sʊdàr	improvement

(Prakrit vocabulary has been taken from *A Comparative Dictionary of the Indo—Aryan Languages* by Turner)

Falling tone is observed on the above examples along with deaspiration of the voiced aspirated sounds but devoicing is not observed. Let us study the acoustic findings of the words with falling tone on them.



Spectogram 5: Spectrogram of [sʊdàr]

In the above spectogram the syllable carrying tone is highlighted. Let us now look at the pitch movements for the above word.

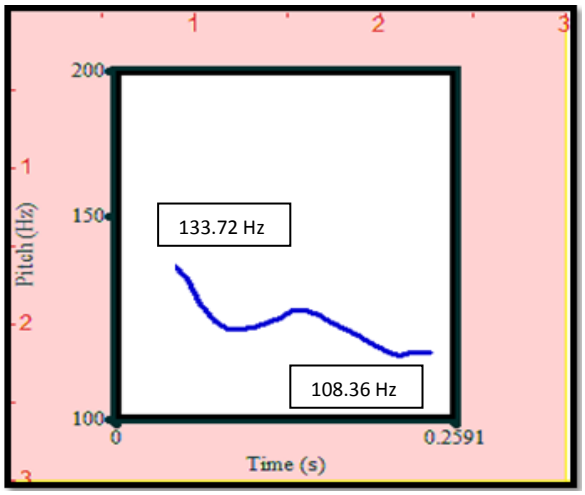
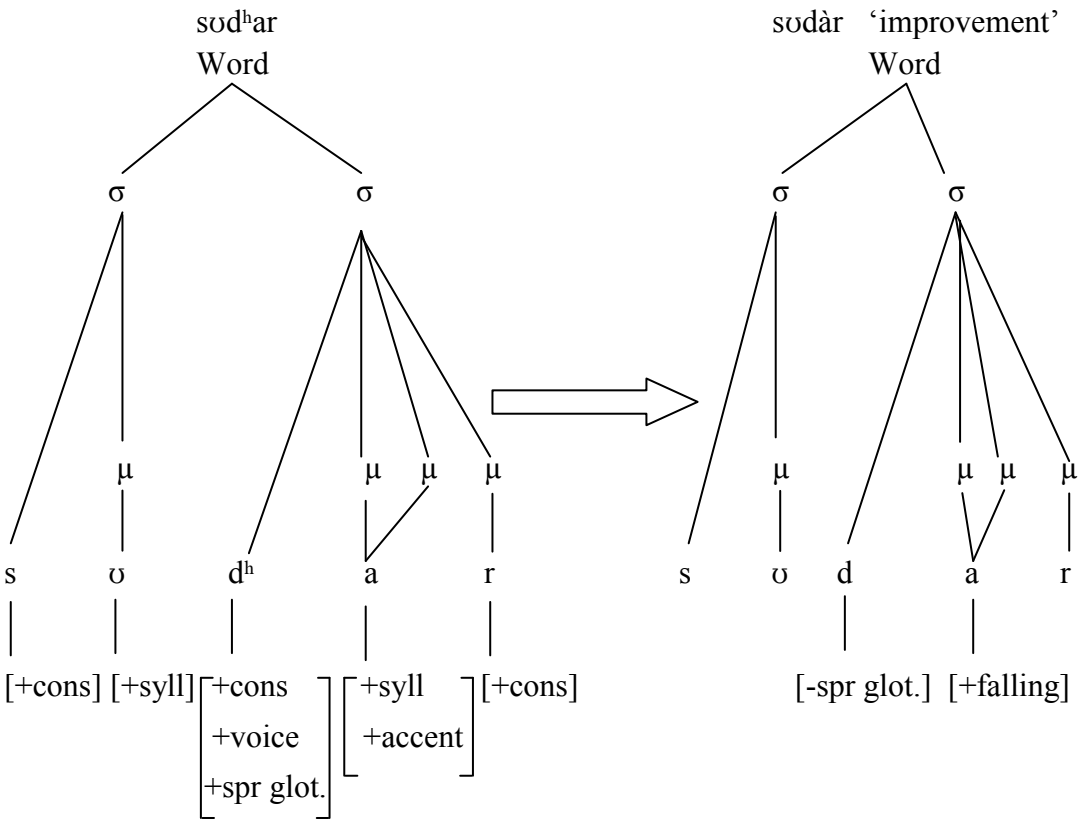


Figure 6: Pitch movements showing falling tone on [sʊdàr]

The above pitch diagram shows that the pitch on the word [sʊdàr] is falling. The difference in the maximum and minimum pitch values is 25.36 Hz in 201.1 ms. The representation below shows falling tone on the word.



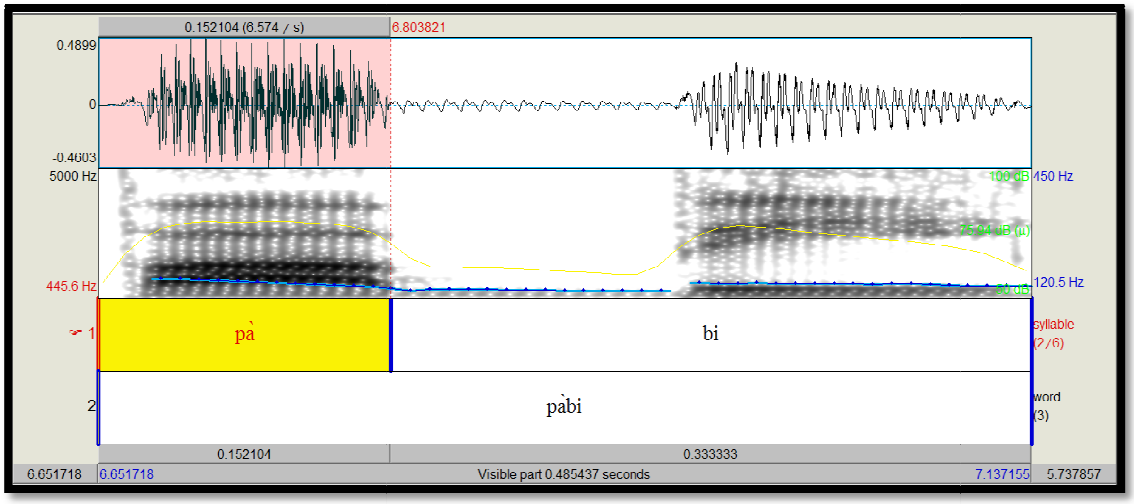
The voiced aspirated sound is observed in the underlying form whereas in the spoken variety, the aspiration is lost and falling tone is developed and no devoicing is observed. In the above examples, a falling tone is developed on the accented syllable which resulted in only deaspiration of the voiced aspirates. Devoicing did not take place. Again the voiced aspirated consonant is preceding the accented syllable. In the above examples, the voiced aspirates are at the syllable initial positions, and, not at word initial positions.

5.1.1.4. Important observations with regard to presence of Tones

The words with double voiced aspirates show only one tone however the deaspiration of both the voiced aspirated sounds takes place. See the examples with their Hindi cognates below.

Sanskrit	Prakrit	Hindi	Punjabi	Gloss
gʰəgʰɪro	gʰaggʰərə	gʰa.gʰra	kə̀g.ra	skirt
bʰabbʰə (underlying form as mentioned in Turner's dictionary)		bʰa.bʰi	pàb.bi	brother's wife

The above examples were put under the heading 'double' tones by Clivio (1966) however there is only one tone that is observed on the word. Gargesh (1999) points out that this could be because of application of Grassman's law, because of which the second aspirated sound lost its aspiration historically. Grassman's law states that words with more than one aspirated sounds retain aspiration only on the first sound and all succeeding sounds lose aspiration. The spectogram of the word [pàbi] is shown below:



Spectogram 6: Spectrogram of [pà.bi]

The above spectogram shows there is falling tone on the penultimate syllable (highlighted part). Let us see the pitch tracings of the rhyme of the penultimate syllable of the word.

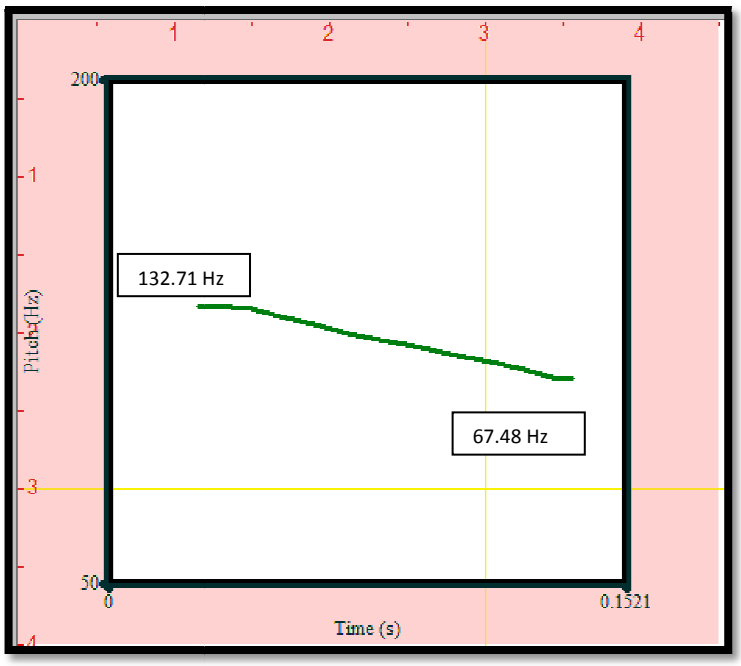
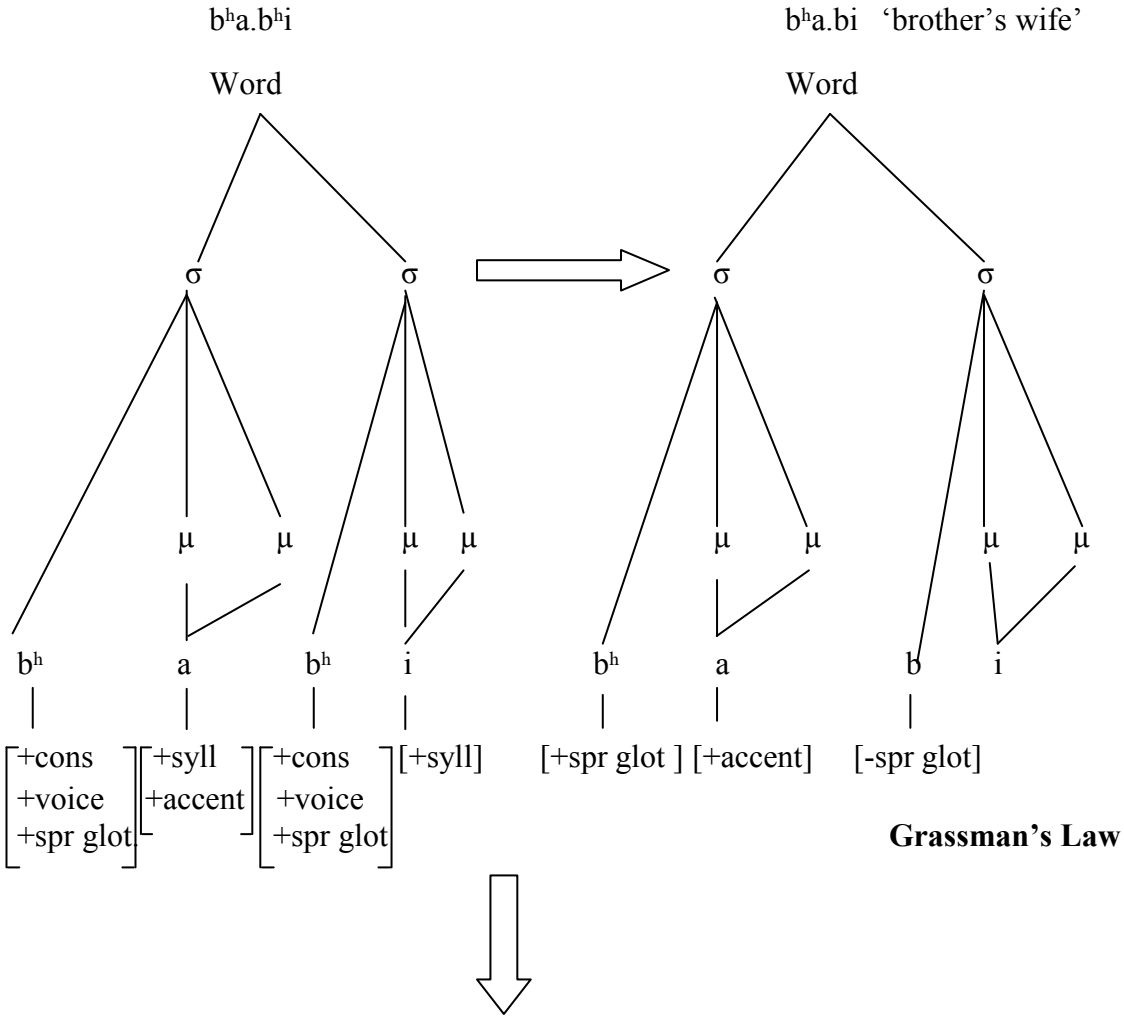
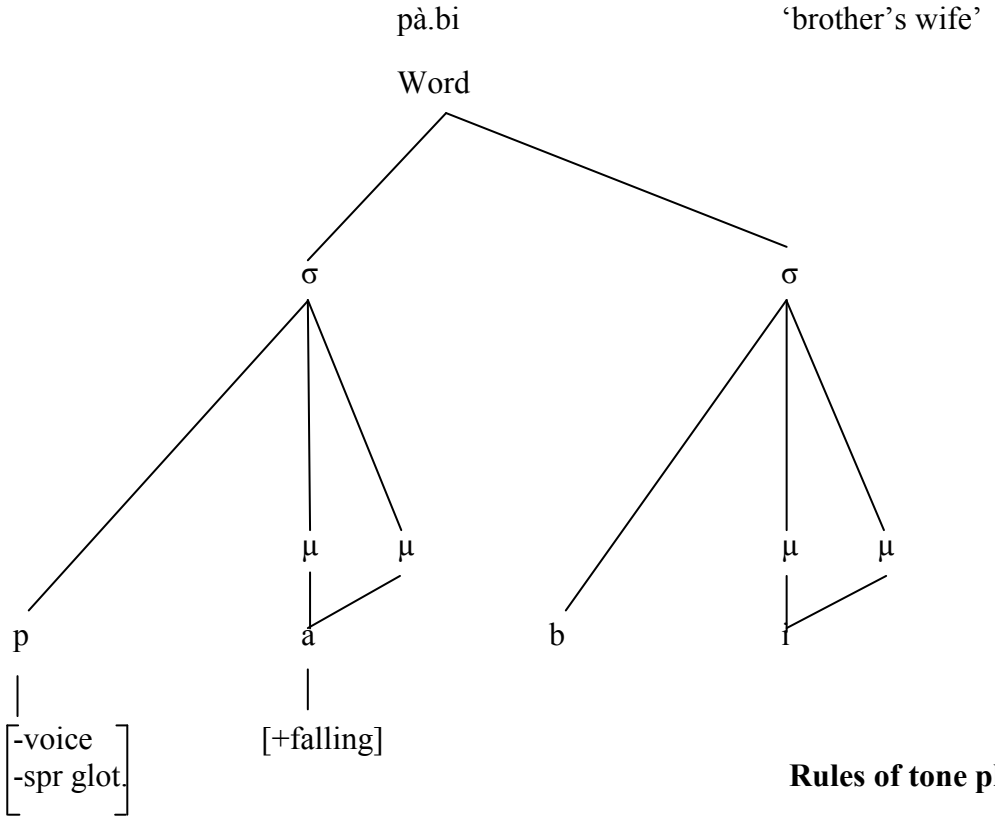


Figure 7: Pitch movements showing falling tone on [pà.bi]

The above pitch diagram shows that the pitch on the word [pàbi] is falling. The pitch has fallen from 132.71 Hz to 67.48 Hz, i.e. 65.23 Hz in 152.1 ms. The representation below shows the presence of falling tone on the word.

The second voiced aspirated sound loses its aspiration due to the application of Grassman's Law hence tone is not observed due to it. This also shows that Grassman's law applies before the rules of tone placement in Punjabi. The application of Grassman's Law can also be confirmed from the fact that words with two voiceless aspirated sounds also do not show aspiration the second time such as in [cʰac] 'salty curd drink' in Punjabi is [cʰacʰ] in Hindi, [cʰəcʊndər] 'shrew' is [cʰəcʰõndər], [kʰak] 'caste' is [kʰakʰ], etc. Hence, the aspiration of the second aspirated sound in the word is lost due to the application of Grassman's law.





5.1.1.5. Presence of Tone on loss of /s/ or /h/

Consider the examples given below where tones are present and absence of /s/ or /h/ sound is observed.

Presence of Tone on loss of /s/ or /h/				
Sanskrit	Prakrit	Hindi	Punjabi	Gloss
trĩʃətə	tisəm	tis	tí	thirty
ʃvasə	sasə	sãs	sə́	breath
kəpahə	kəppasə	kə.pas	kə.pá	cotton plant
grhə	gaha/ grhə́	greh	gré	stars
lohə	lo:ha	lo.ha	lóa	iron
lohkarə	lo:harə	lʊ.har	lʊàr	iron smith

(Prakrit vocabulary has been taken from *A Comparative Dictionary of the Indo—Aryan Languages* by Turner)

Tones are observed on the above examples and there is loss of /s/ or /h/ sound. It is observed that tone develops depending on the placement of accent and the /s/ or /h/ sound in the word. If the deleted sound is preceding the accented syllable, falling tone develops and if the deleted sound is following the accented syllable, rising tone develops.

5.1.1.6. Tones in Western Punjabi

It is to be noted here that the discussion on tones in the present work is applicable to Eastern Punjabi only. In the data collected from the speakers of Western Punjabi, tones are observed on all the words with voiced aspirated consonants but there is no deaspiration or devoicing. Since the recordings were done at home, the spectograms are not clear.

The type of tone present in Western Punjabi can be predicted, like in Eastern Punjabi. If the voiced aspirated sounds precede the accented syllable, falling tone is observed and if the voiced aspirated sounds follow the accented syllable, rising tone is observed. Also, the tone rests on the accented syllable, just as in Eastern Punjabi. Hence, the rules proposed in the chapter for tone placement are applicable only to Eastern Punjabi.

5.1.2 Generalizations

The above observations imply that falling tone is developed if the voiced aspirated consonants precede accented vowel and rising tone is developed if the voiced aspirated consonants follows the accented vowel. Therefore, falling tone is a result of rightward arising of the tone whereas rising tone is a result of the leftward arising of the tone. Also, devoicing takes place if the voiced aspirated consonant is at word-initial position. Keeping the above data and observations in mind, the following rules of tone placement are formulated. The rules given below were proposed by Gargesh (1999) and followed by Singh (2004) for the placement of tones in Punjabi. However, Gargesh (1999) has talked about arising of tones on loss of /s/ and /h/ sounds, he has not included the account of the same in rule formation. Hence, the first rule has been modified to accommodate presence of tone on loss of sound segments such as /s/ or /h/. Also, the terms ‘high’ and ‘low’ tones used by most scholars working on tones in

Punjabi have been replaced by 'rising' and 'falling' since the pitch diagrams plotted clearly show the rise or fall in pitch.

Rules of Tone Placement in Eastern Punjabi

a) All voiced aspirated consonants in orthography of Punjabi lose aspiration or a sound segment and tone is observed in the spoken variety. The tone rests on the accented syllable, therefore, every word has only one tone.

b) Falling tone is observed as a result of the rightward arising of the tone and rising tone is observed as a result of the leftward arising of the tone.

c) Devoicing will also take place iff the voiced aspirated consonant is at the word-initial position.

The above rules make it possible to predict the exact location and nature of occurrence of tone. The present work has also proposed that Grassman's law applies before rules of tone placement.

Having understood the relation between voiced aspirated consonants and tones in Punjabi, the intonation of different utterances is examined in the next section.

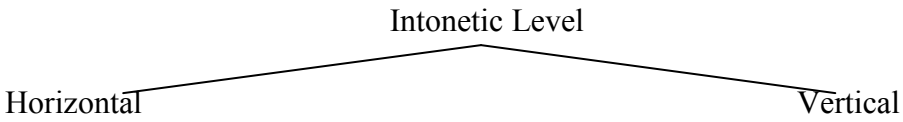
5.2. Intonation

Every language has intonation as it is a universal feature of languages. It conveys linguistic as well as paralinguistic meanings in conversation. Most studies on intonation have analyzed Indo-European languages, however not much work has been done on the intonation of Punjabi language. f0 (perceived as pitch) is the primary correlate cue of intonation as well as tone. However, one needs to keep in mind that f0 at syllabic level represents tone and at sentential or phrasal level represents intonation. Duration and loudness are also cues to intonation. Not much, but some valuable work has been done on the intonation of Punjabi.

Some scholars like Gill and Gleason (1969), Joshi's (1972, 1989) have recognized the significance of emphasis in discourse as one of the devices to analyze sentences, however, they haven't discussed those in detail. Joshi's (1972, 1989) has focused only on the intonation of the last syllable of different types of clauses. Kalra (1982) has talked about intonation in the context of tones in Punjabi, has pointed that the cues to both are pitch and fundamental frequency (p. 296). However, he does not talk about

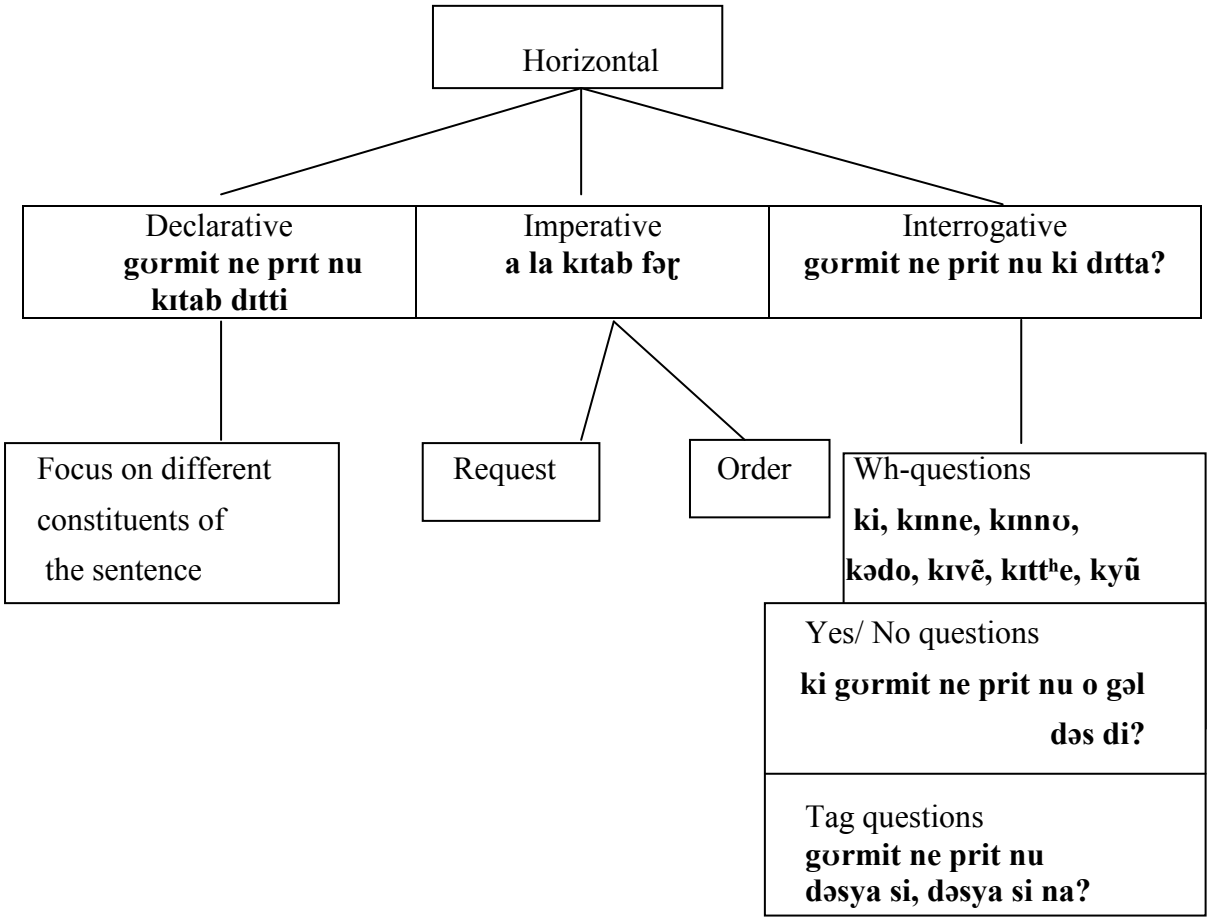
intonation patterns, or make any generalization with regard to intonation of Punjabi. Sandhu (1974), on the other hand, has given an experimental analysis of Punjabi vowels and consonants, and not talked about intonation. Malik (1995) studies the intonation of phrases, however, he doesn't make any generalizations. Gill and Gleason (2013) states that intonation is an important feature in learning spoken Punjabi (p. 8), however, they do not make an effort to study the different intonation patterns or discuss it in detail. They only state that the intonation of different sentences like that of declarative sentences and questions will be different from each other. Bhatia (1993) has claimed four intonation patterns in Punjabi that have syntactic functions: high-fall, high-rise, rise and fall and mid level. High-fall is attested in statements, high-rise in yes-no questions, rise and fall in questions and mid level in commands. Contrastive and emphatic intonation employs stronger stress than the normal. The constituent to be contrasted carries more stress than the constituent to be emphasized (p. 345-346).

Singh (2006) compared the intensity, pitch (minimum and maximum) and duration of the various horizontal and vertical sentences in Punjabi. He explains that one intonemic level sentence can have many intonetic levels which are discourse motivated. Intonemic level sentences are the underlined form of sentences whereas the intonetic levels are the different surface realizations of those intonemic levels. Intonetic levels are discourse motivated. He gives the following classification:

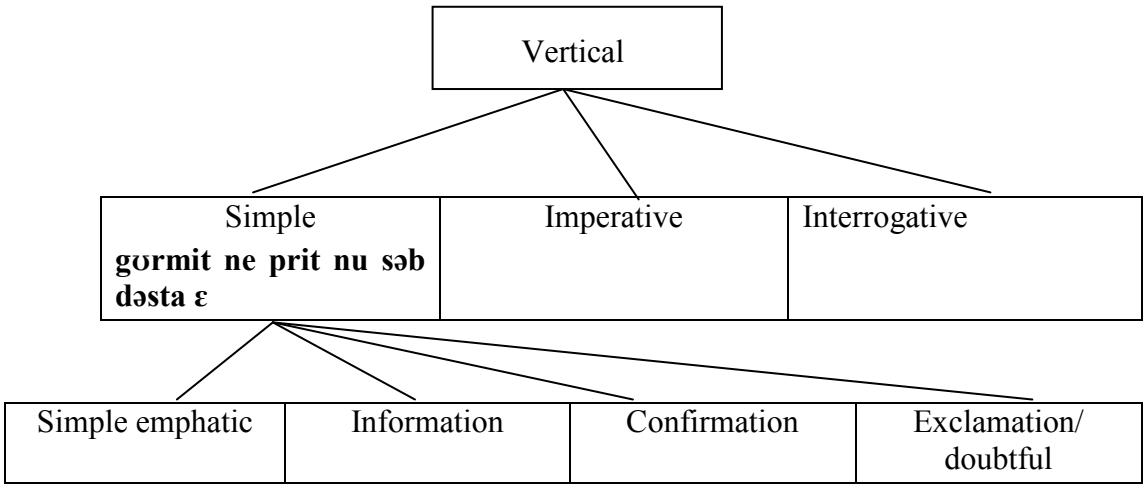


Horizontal level is locating the nucleus or emphasis on different constituents in the sentence. The present study will look at intonetic levels in discourse motivated horizontal sentences in declaratives, imperatives and interrogatives. In a declarative sentence, the emphasis will be put on different constituents of the sentence- subject, object and verb and the findings will be compared. Similarly, the intonation of imperatives (request and order) will be studied by putting emphasis on different parts of the sentence and the findings will be compared to understand the intonation in request and order sentences. Intonation of interrogative sentences will also be studied in Punjabi. The intonation of wh-questions, tag questions and yes/ no questions will

be studied. The present work will compare the findings of sentences spoken with different intonations to arrive at valid conclusions. The examples of the above mentioned type of sentences are given below in the diagram.



Vertical is represented by changing the discourse frame in order to conform, inform, show surprise/ doubt, etc. The present work will study intonation of only simple vertical sentences. The findings of the sentences spoken with simple vertical intonation pattern (simple, information, confirmation and exclamation) will be studied and compared to arrive at generalizations.



Singh (2006) shows the differences in the spectrograms and acoustic cues to intonation of all the above types of sentences. Singh (2006) takes duration, minimum f0, maximum f0 and maximum intensity to be acoustic cues for the study of intonation. Different scholars have claimed that amplitude is also a cue to intonation in various languages. The phonetic model recognizes the importance of amplitude in understanding of intonation (Fujisaki, 1983, p. 44-48). Gu et al (2006) has reported that amplitude is significant in understanding intonation in Cantonese (p. 64). Morrow and Liu (2013) studied the role of amplitude in understanding the intonation of English sentences. It is reported that Mandarian Chinese speakers use amplitude and duration cues to understand intonation contrasts as f0 contours carry lexical information in the language. Amplitude has emerged to be a significant cue to intonation in other languages whereas intensity doesn't give that much information because it is a larger unit. Amplitude is a smaller unit for loudness hence it will look at the loudness of speech sound in detail. Therefore, the present work will verify and validate the findings of Singh (2006) by analyzing amplitude in place of the intensity cue and so the present work has chosen the same types to sentences to study intonation patterns. Also, the present work will collect data from native speakers of Punjabi. The present will look at the different intonation patterns in Punjabi and compare the duration, minimum and maximum f0 and maximum amplitude for different types of sentences. Hence, an experiment was conducted to study the various possible surface realizations (intonetic level) of sentences and the duration, minimum

and maximum f0 values and maximum amplitude of the constituents of various intonetic levels were studied to get the complete picture of intonation pattern in Punjabi language. It is proposed in the present work that amplitude is an acoustic cue to the perception of intonation in Punjabi.

5.2.1. Results

5.2.1.1 Intonation Patterns of Horizontal Declarative Sentences

Let us first look at the findings of horizontal sentences (declarative) in which different constituents of the sentences will be emphasized.

gʊrmit ne	prɪt nu	kɪtab	dɪtti
Gurmeet.erg	to Preet	book	gave
Subject	Indirect object	Direct object	Verb

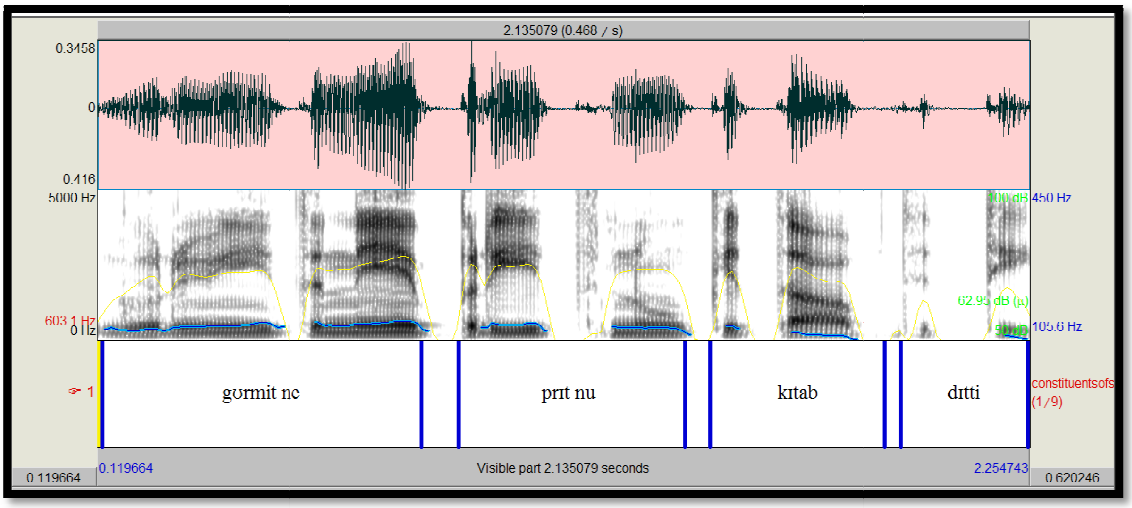
Gurmeet gave a book to Preet.

The acoustic findings of the above horizontal sentence will be studied below. Different constituents of the sentence will be emphasized and the findings will be compared to arrive at valid generalizations. Let us look at the findings of each constituent separately with no emphasis on any constituent of the sentence.

Table 8: Findings of simple horizontal declarative sentence

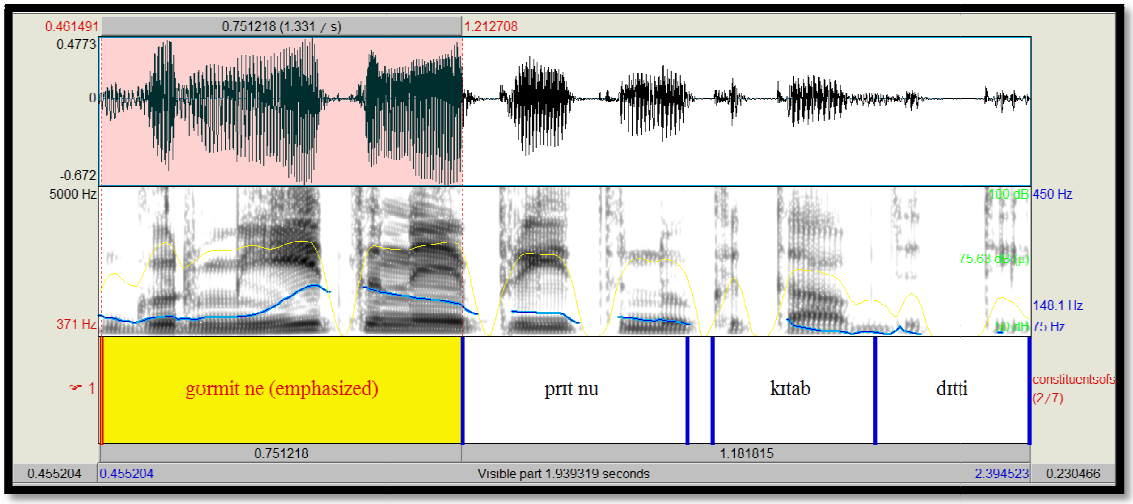
gʊrmit ne prɪt nu kɪtab dɪtti (no constituent emphasized)				
	gʊrmit ne (subject)	prɪt nu (indirect object)	kɪtab (direct object)	dɪtti (verb)
Duration	760.6 ms	490.2 ms	392 ms	325.1 ms
f0	122.2 Hz	114.9 Hz	99.8 Hz	87.56 Hz
Minimum amplitude	-0.5940 Pa	-0.4086 Pa	-0.3185 Pa	-0.1112 Pa
Maximum amplitude	0.5049 Pa	0.3141 Pa	0.3498 Pa	0.0893 Pa
Difference in Amplitude values	1.0989 Pa	0.7227 Pa	1.0181 Pa	0.2005 Pa

The above table shows the findings of the simple horizontal declarative sentence. The duration of the subject is maximum (760.6 ms) and that of the verb is the minimum (375.1 ms). The duration of indirect object (490.2) is more than that of the direct object (389.4 ms). The f0 of the verb (94.1 Hz) is the lowest and that of the subject is the highest (122.2 Hz). The f0 of indirect and direct objects are 114.9 Hz and 99.8 Hz respectively. Maximum amplitude of the subject is highest (0.5049 Pa) and that of the verb is lowest (0.1886 Pa). The maximum amplitudes of direct and indirect objects are very close with a very little difference (maximum amplitude of direct object is 0.3498 Pa and that of indirect object is 0.3141 Pa). The difference in the maximum and minimum amplitude values is the most for the subject (1.0989 Pa) and the least for verb (0.4156 Pa). The difference in amplitude values of direct object is 1.0181 Pa which is more than the difference in amplitude values for indirect object (0.7227 Pa). The spectogram of the above sentence is shown below:



Spectogram 7: Spectogram of the horizontal sentence [gʊrmit nɛ prɪt nu kɪtab dɪtti] (no constituent emphasized)

Let us look at the acoustic findings when a constituent in the sentence is emphasized. The findings of the emphasized subject are given below and are compared with the findings of the subject in the sentence above where it is not emphasized.



Spectogram 8: Spectrogram of a horizontal declarative sentence [gʊrmit ne prɪt nu kɪtab dɪtti] with subject [gʊrmit ne] emphasized

In the above spectogram, the words of the sentences are marked on the lowermost tier and the emphasized constituent in the sentence (subject here) is being highlighted in the spectogram. The acoustic findings for the same are given below.

Table 9: Findings of horizontal declarative sentence (subject emphasized)

	Subject emphasized	**Subject not emphasized**
Duration	755.1 ms	760.6 ms
f0	147.95 Hz	122.2 Hz
Minimum amplitude	-0.6720 Pa	-0.5940 Pa
Maximum amplitude	0.5773 Pa	0.5049 Pa
Difference in Amplitude values	1.8213 Pa	1.0989 Pa

The difference in the duration of the subject (simple) and emphasized subject is very little (5.5 ms). The duration of subject is 760.6 ms whereas the duration of the emphasized subject is 755.1 ms. The f0 of the emphasized subject is considerably higher than that of simple subject (122.2 Hz when not emphasized and 147.95 Hz when emphasized). There is also a difference of 0.0724 Pa in the maximum amplitude of the subjects (0.5049 Pa when not emphasized and 0.5773 Pa when emphasized). The difference in the maximum and minimum amplitude values of the emphasized subject (1.8213 Pa) is more than the difference in case of the non-emphasized subject (1.0989 Pa). The pitch diagram below shows the pitch movement of the subject-normally spoken and emphasized.

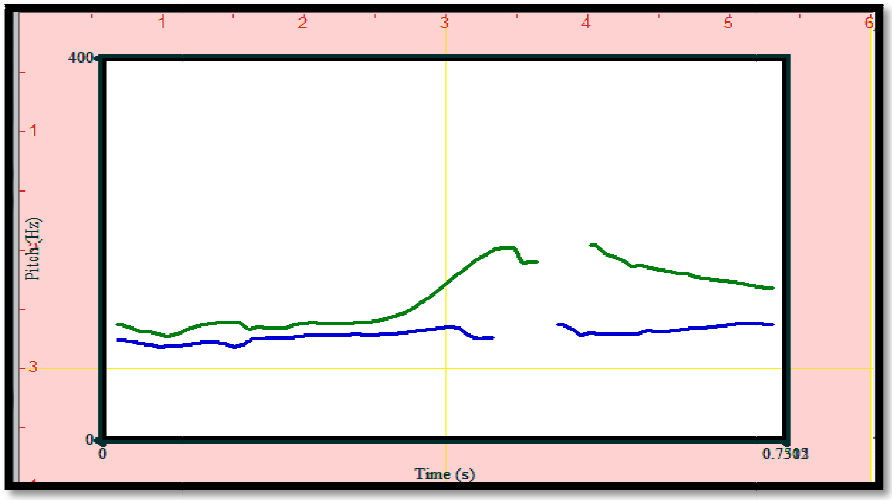
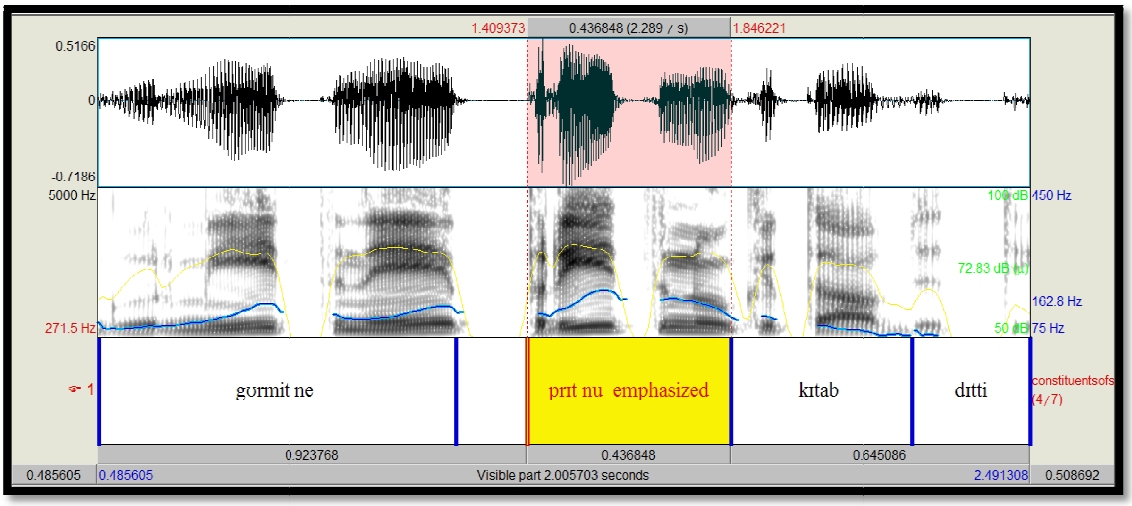


Figure 8: Comparison of pitch movements of subject (emphasized and simple) in a horizontal declarative sentence

The above pitch diagram shows the pitch of the subject when it is emphasized (in green) versus when it is spoken normally (in blue). The maximum pitch of the emphasized subject is higher than the maximum pitch of the subject spoken otherwise. This shows that the putting emphasis on the subject results in rise in pitch. The maximum amplitude of the emphasized subject is slightly more than the maximum amplitude of the subject spoken normally. Let us see if object- emphasized and simple, also follow the same pattern.



Spectogram 9: Spectrogram of a horizontal declarative sentence [gʊrmit ne prɪt nu kɪtab dɪtti] with indirect object [prɪt nu] emphasized

In the above spectogram, the words of the sentences are marked on the lowermost tier and the object is highlighted as it is being emphasized in the sentence.

Table 10: Findings of horizontal declarative sentence (indirect object emphasized)

	Indirect object emphasized	**Indirect object not emphasized**
Duration	437.8 ms	490.2 ms
f0	162.5 Hz	114.9 Hz
Minimum amplitude	-0.7185 Pa	-0.4086 Pa
Maximum amplitude	0.5166 Pa	0.3141 Pa
Difference in Amplitude values	1.2351 Pa	0.7227 Pa

The duration of the object has decreased when emphasized. The duration of the object when spoken normally is 490.2 ms whereas the duration of the emphasized object is 437.8 ms. The f0 of the object spoken normally is 114.9 Hz whereas the f0 of the object when emphasized is 162.5 Hz. There is a difference of 47.6 Hz in the f0 of the two. The maximum amplitude of the emphasized object (0.5166 Pa) is also more than the maximum amplitude of the object (0.3141 Pa) otherwise. The difference in the maximum and minimum amplitude of the emphasized object (1.2351 Pa) is also much higher than the difference in case of non-emphasized object (0.7227 Pa). This shows the rise in amplitude in emphasized object. The pitch diagram below shows the pitch movement of the object- normally spoken and emphasized.

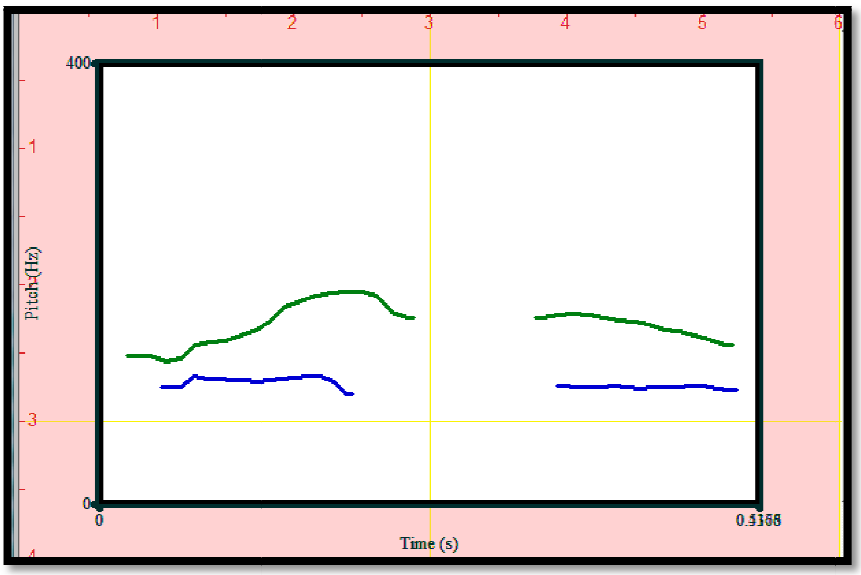
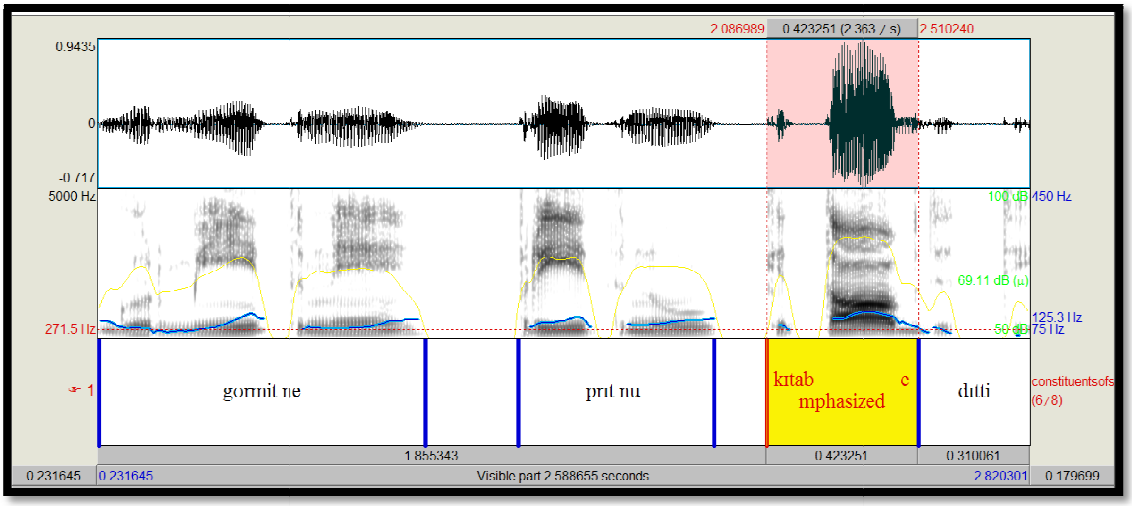


Figure 9: Comparison of pitch movements of indirect object (emphasized and simple) in a horizontal declarative sentence

The above pitch diagram shows the pitch of the indirect object when it is emphasized (in green) versus when the indirect object is spoken normally (in blue). The minimum and the maximum pitch of the emphasized indirect object are higher than the minimum and maximum pitch of the indirect object spoken normally. Let us see if the same is observed in case of direct object also.



Spectogram 10: Spectrogram of a horizontal declarative sentence [gɔrmit ne prɪt nu kɪtab dɪtti] with indirect object [kɪtab] emphasized

In the above spectogram, the words of the sentences are marked on the lowermost tier and the object is highlighted as it is being emphasized in the sentence.

Table 11: Findings of horizontal declarative sentence (direct object emphasized)

	Direct object emphasized	**Direct object not emphasized**
Duration	389.4 ms	392 ms
f0	125.4 Hz	99.8 Hz
Minimum amplitude	-0.7170 Pa	-0.3185 Pa
Maximum amplitude	0.9435 Pa	0.3498 Pa
Difference in Amplitude values	1.2351 Pa	1.0181 Pa

The duration of the direct object has decreased from 392 ms to 389.4 ms when emphasized. The f0 of the direct object spoken normally is 99.8 Hz whereas the f0 of the direct object when emphasized is 125.4 Hz. There is a difference of 25.6 Hz in the f0 of the two. The maximum amplitude of the emphasized direct object (0.9435 Pa) is

also more than double the maximum amplitude of the direct object (0.3498 Pa) otherwise. The difference in the maximum and minimum amplitude of the emphasized direct object (1.2351 Pa) is also considerably more than in case of non-emphasized object (1.0181 Pa). This shows the rise in amplitude in emphasized direct object. The pitch diagram below shows the pitch movement of the direct object-normally spoken and emphasized.

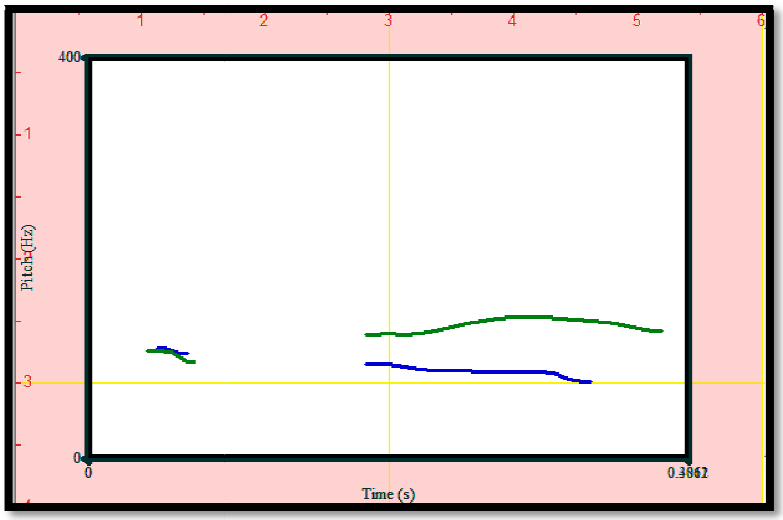
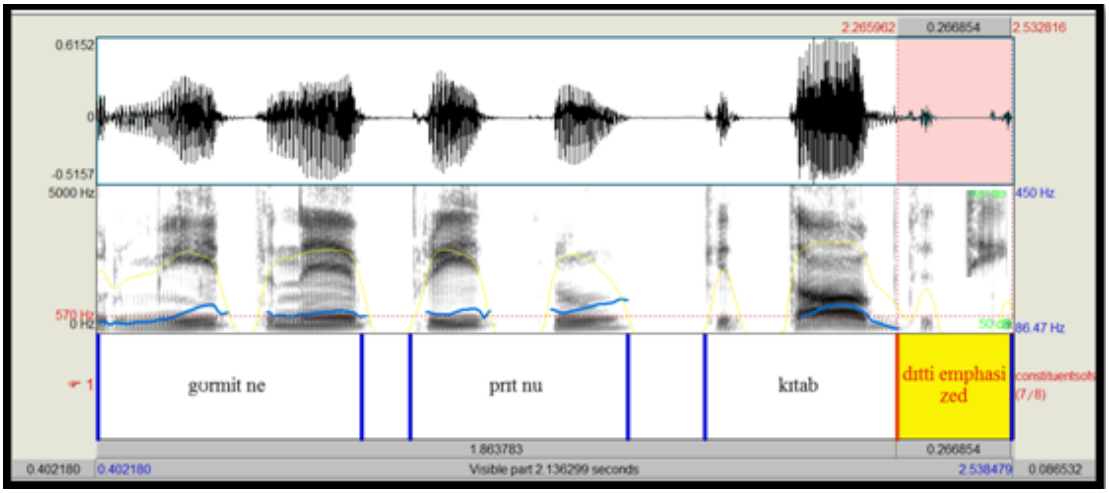


Figure 10: Comparison of pitch movements of direct object (emphasized and simple) in a horizontal declarative sentence

The above pitch diagram shows the pitch of the direct object when it is emphasized (in green) versus when the direct object is spoken normally (in blue). The acoustic findings for emphasized verb are given below.



Spectogram 11: Spectrogram of a horizontal declarative sentence [gʊrmit ne prɪt nu kɪtab dɪtti] with verb [dɪtti] emphasized

In the above spectogram, the words of the sentences are marked on the lowermost tier and the verb is highlighted as it is being emphasized in the sentence.

Table 12: Findings of horizontal declarative sentence (verb emphasized)

	Verb emphasized	**Verb not emphasized**
Duration	313.5 ms	325.1 ms
f0	94.1 Hz	87.56 Hz
Minimum amplitude	-0.2271 Pa	-0.1112 Pa
Maximum amplitude	0.1886 Pa	0.0893 Pa
Difference in Amplitude values	0.4156 Pa	0.2005 Pa

The duration of the verb has decreased from 325.1 ms to 313.5 ms on being emphasized. The f0 of the verb spoken normally is 87.56 Hz, whereas the f0 of the emphasized verb is 94.1 Hz. The maximum amplitude of the verb is more than double when emphasized. The maximum amplitude of the emphasized verb is 0.1886 Pa whereas the maximum amplitude of the verb spoken normally is 0.0893 Pa. The difference in the maximum and minimum amplitude of the emphasized verb (0.4156 Pa) is also almost twice the difference in case of non-emphasized verb (0.2005 Pa). The same was observed in the case of subject and direct and indirect object too. The pitch diagram below shows the pitch movement of the verb- normally spoken and emphasized.

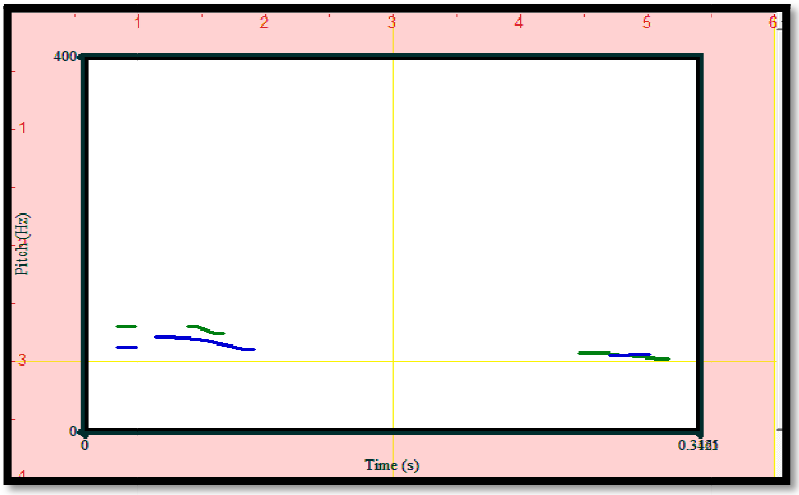


Figure 11: Comparison of pitch movement of verb (emphasized and simple) in a horizontal declarative sentence

The above pitch diagram shows that the pitch of the verb spoken normally (in blue) and the emphasized verb (in green). One can see here that the minimum and the maximum pitch of the emphasized verb are higher than the minimum and maximum pitch of the verb spoken normally. Hence one can deduce that the pitch range increases when a constituent is emphasized in the sentence.

It is observed that, in horizontal declarative sentences, the f0 and maximum amplitude values are more for all constituents (subject, direct object, indirect object and verb) when emphasized and the difference in maximum and minimum amplitude values were greater for the emphasized constituents in comparison to their non-emphasized counterparts. The duration values are consistently lower for emphasized constituents in comparison to non-emphasized constituents.

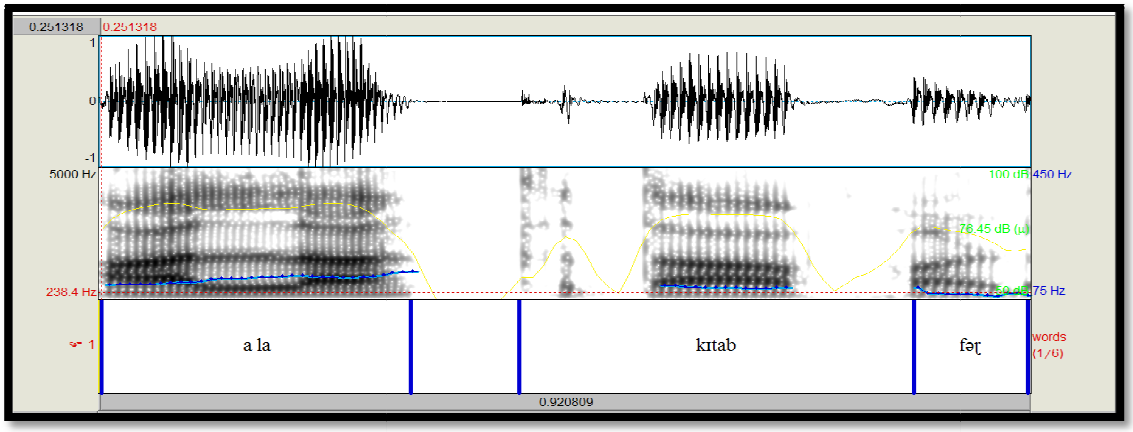
5.2.1.2 Intonation Patterns of Imperative Sentences (Request and Order)

We will now take a look at the intonation patterns of imperatives (request and order) in Punjabi. The sentence below will be used to study and compare the acoustic findings in imperatives (request and order) in Punjabi.

a la	kɪtab	fəʈ	
this	take	book	hold

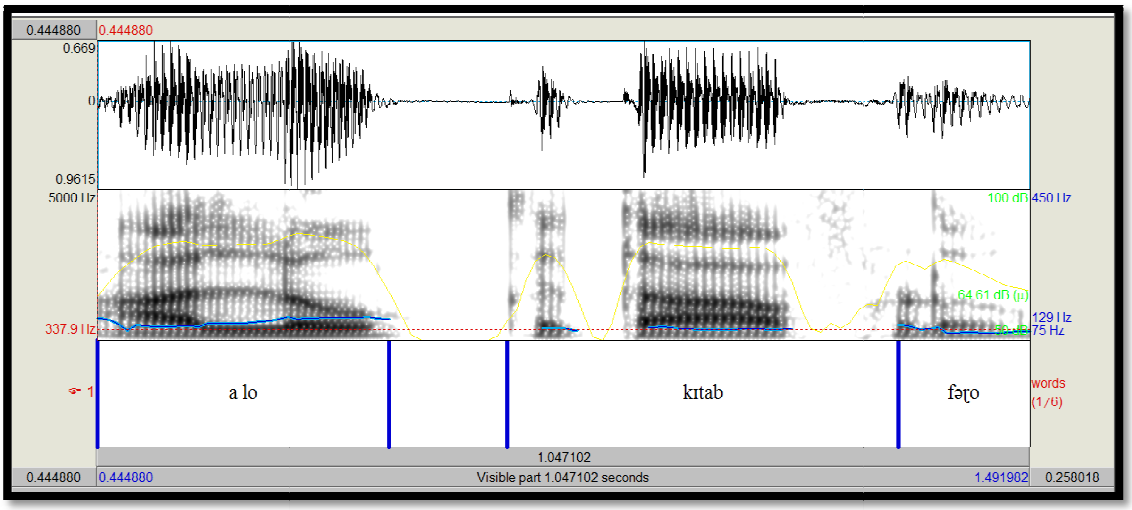
Hold the book.

Let us look at the findings when the sentence is spoken with simple intonation.



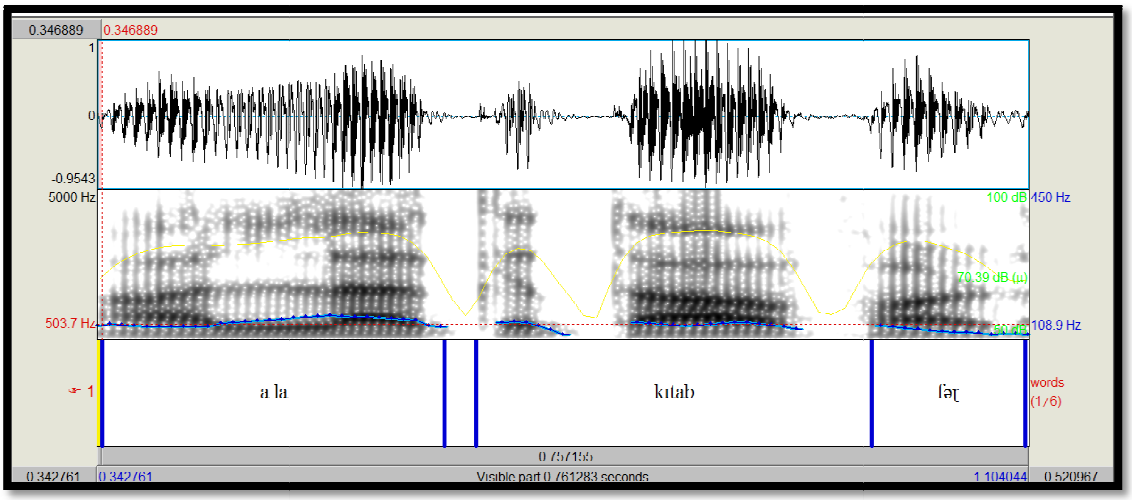
Spectogram 12: Spectrogram of simple sentence [a la kɪtab fəʈ]

The above spectogram shows the intonation of the sentence [a la kɪtab fəɽ] spoken with simple intonation. Let us see the spectograms of the same sentence with imperative intonation below.



Spectogram 13: Spectrogram of an imperative (request) sentence [a lo kɪtab fəɽo]

The spectogram of request imperative sentence is shown above and in an order imperative sentence is shown below.



Spectogram 14: Spectrogram of an imperative (order) sentence [a la kɪtab fəɽ]

The acoustic findings for the sentence [a la kɪtab fəɽ] with simple, request and order intonation are given below.

Table 13: Findings of simple and imperative intonation

	Simple	**Request**	**Order**
Duration	924.2 ms	1047.1 ms	761.2 ms
f0	118.47 Hz	110.1 Hz	110.9 Hz
Minimum amplitude	-0.9770 Pa	-0.9615 Pa	-0.9542 Pa
Maximum amplitude	0.8687 Pa	0.6690 Pa	0.9999 Pa
Difference in Amplitude values	1.8457 Pa	1.6305 Pa	1.9541 Pa

The above table shows the duration, f0 and amplitude values for the sentence [a la kɪtab fəɽ] spoken with simple intonation and with imperative intonation- request and order. The duration for speaking it with simple sentence (924.2 ms) is lesser than with request intonation (1047.1 ms) but more than in making order (761.2 ms). The f0 is almost the same for sentences with request intonation (110.1 Hz) and with order (110.9 Hz). The f0 of the simple sentence is slightly higher, 118.47 Hz. The maximum amplitude of order sentence (0.9999 Pa) is highest and for request sentence (0.6690 Pa) is lowest whereas the maximum amplitude of the simple sentence is 0.8687 Pa. The difference in the maximum and minimum amplitude values of the sentence is the most in order sentence (1.9541 Pa) which shows the maximum change in amplitude followed by simple sentence (1.8457 Pa). The difference is the least in request sentence (1.6305 Pa). The pitch diagram below shows the difference in the pitch movements of simple, order and request sentences.

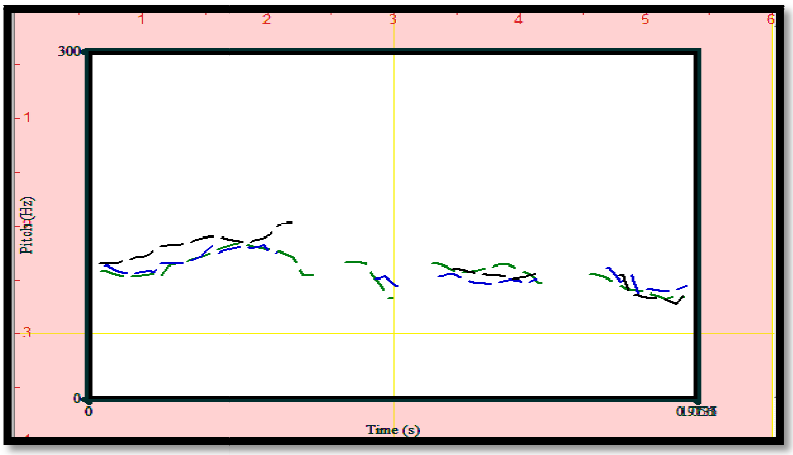


Figure 12: Comparison of pitch tracings of simple, order and request intonation

The above pitch diagram shows the pitch of the sentence spoken with simple intonation (in blue) and with imperative intonation- request (in green) and order (in black). It is observed that the pitch for order sentence remains higher than that for the other two. The pitch of the simple and request sentences look close however the pitch of the request sentence is slightly lower than that of the simple sentence.

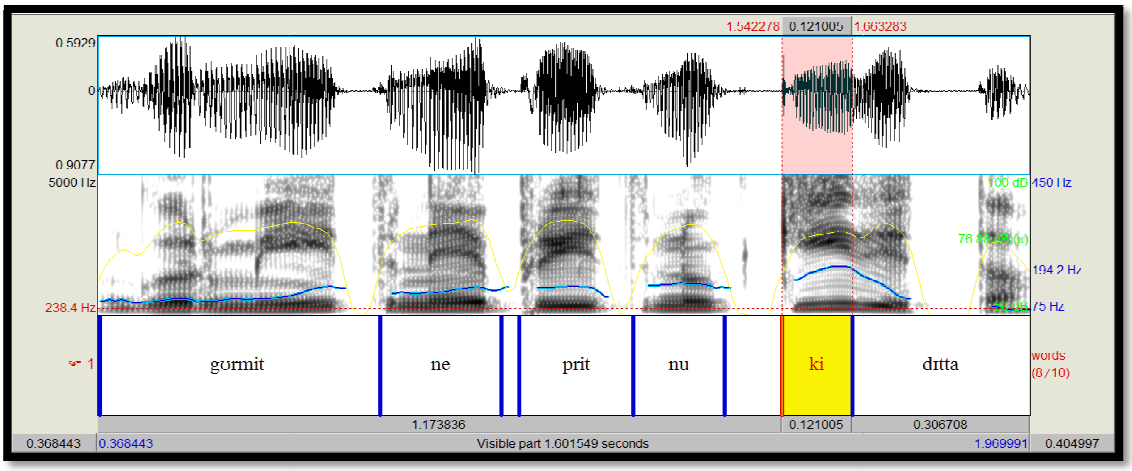
It is observed that the maximum amplitude values are highest for order sentences, followed by in simple sentences and the maximum amplitude values are found to be the least in requests. Also, the difference between the maximum and minimum amplitude values is the widest in order sentences which means that in order sentences, there is more amplitude change compared to the simple and request sentences. The difference in maximum and minimum amplitude values is observed to be lowest in request sentences. The f0 values are found to be the highest for simple sentences whereas the f0 values are almost same for request sentences and for order sentences. The duration is the highest in request sentences and the least in order sentences.

5.2.1.3 Intonation Patterns of Questions

To study the intonation pattern of questions in Punjabi, various constituents of a simple sentence were questioned and the findings for the same are discussed below. The sentence below questions 'what' [ki] in Punjabi.

gʊrmit	ne	prit	nu	**ki**	dɪtta?	'what'
Gurmeet	erg	Preet	to	what	gave	

What did Gurmeet give to Preet?



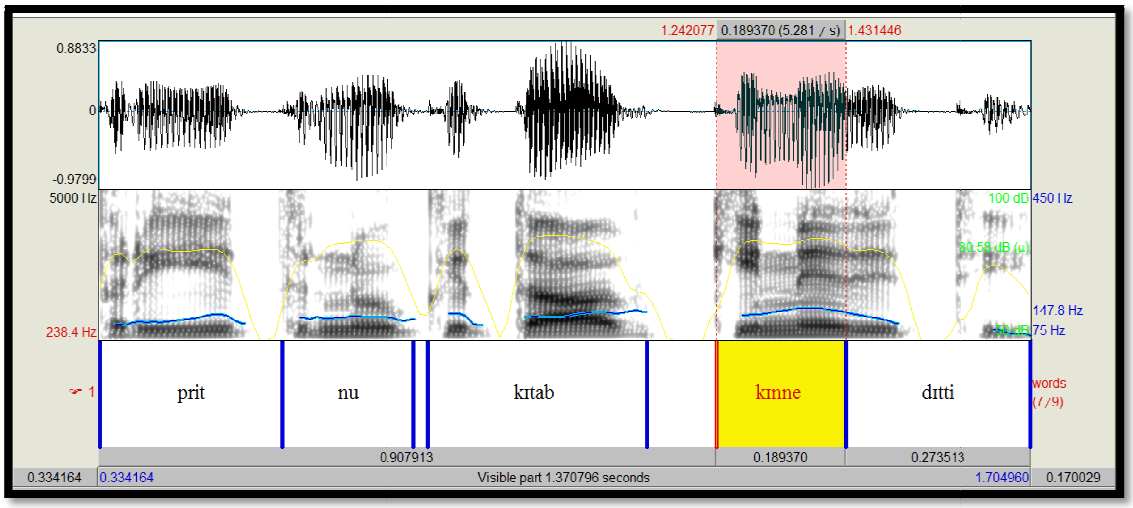
Spectogram 15: Spectrogram of question [ki] in [gʊrmit ne prit nu ki dɪtta?]

In the above spectogram, the words of the sentences are marked on the lowermost tier and the question word [ki] is highlighted. The acoustic findings for the question word are given below.

Table 13: Duration, f0 and amplitude values for question [ki] in Punjabi

Duration	121.4 ms
f0	195.2 Hz
Minimum amplitude	-0.4659 Pa
Maximum amplitude	0.3868 Pa
Difference in Amplitude values	0.8527 Pa

The above table shows the acoustic measurements for the question [ki] in Punjabi. The duration for speaking the question word is 121.4 ms. The f0 is 195.2 Hz and the maximum amplitude is 0.3868 Pa. The difference in the maximum and minimum amplitude values is 0.8527 Pa. We shall study the spectogram and acoustic findings for the question word [kɪnne] below.



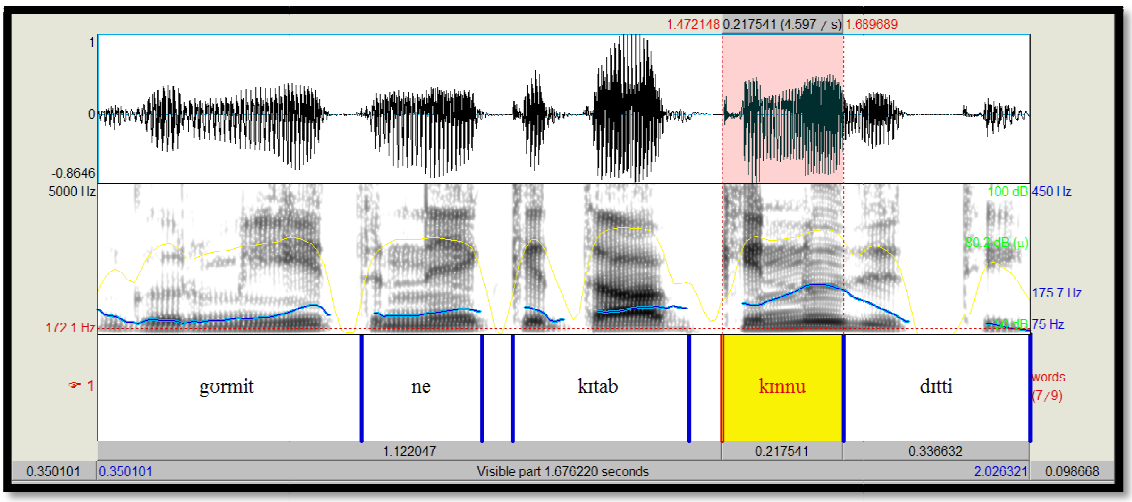
Spectogram 16: Spectrogram of question [kɪnne] in [prit nu kɪtab kɪnne dɪtti?]

In the above spectogram, the words of the sentences are marked on the lowermost tier and the question word [kɪnne] is highlighted. The acoustic findings for the question word are given below.

Table 14: Duration, f0 and amplitude values for question [kɪnne]

Duration	189.3 ms
f0	147.8 Hz
Minimum amplitude	-0.9798 Pa
Maximum amplitude	0.4878 Pa
Difference in Amplitude values	1.4676 Pa

The duration for the question [kɪnne] is 189.3 ms. The f0 is 147.8 Hz and the maximum amplitude for the question word [kɪnne] is 0.4878 Pa. The difference in the maximum and minimum amplitude values is 1.4676 Pa. Let us look at the acoustic findings for the question word [kɪnnʊ]



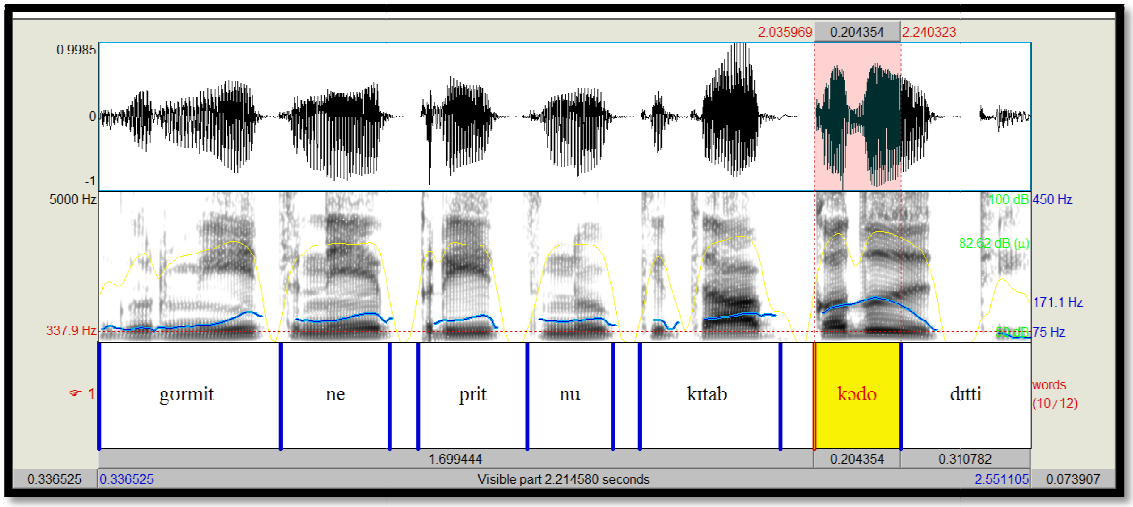
Spectogram 17: Spectrogram of question [kɪnnʊ] in [gʊrmit ne kɪtab kɪnnʊ dɪtti?]

In the above spectogram, the words of the sentences are marked on the lowermost tier and the question word [kɪnnʊ] is highlighted. The acoustic findings for the question word are given below.

Table 15: Duration, f0 and amplitude values for question [kɪnnʊ] in Punjabi

Duration	217.5 ms
f0	195.6 Hz
Minimum amplitude	-0.8594 Pa
Maximum amplitude	0.4959 Pa
Difference in Amplitude values	1.3553 Pa

The duration for the question word [kɪnnʊ] is 217.5 ms. The f0 is 195.6 Hz, whereas the maximum amplitude is 0.4959 Pa. The difference in the maximum and minimum amplitude values is 1.3553 Pa. Consider the acoustic findings for the question word [kədo]



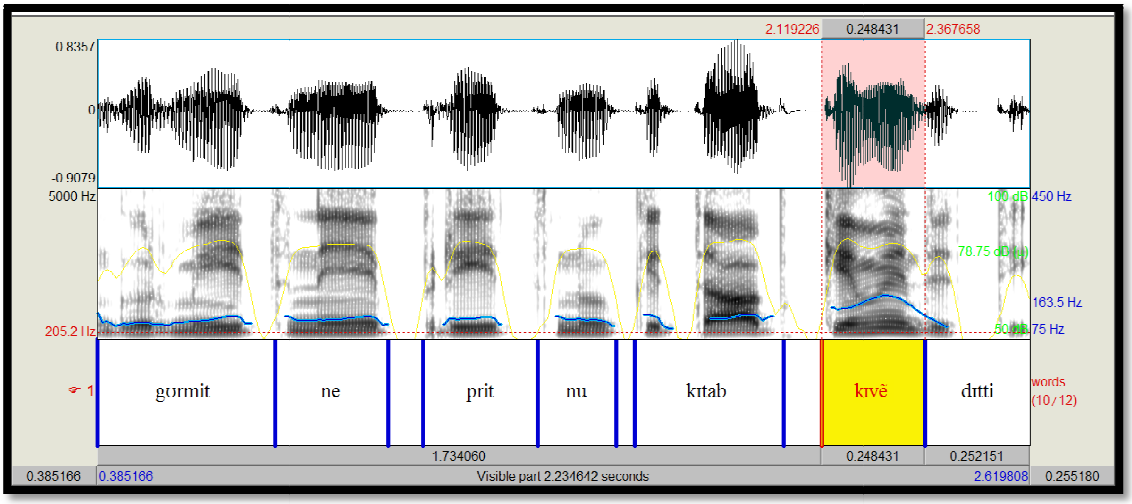
Spectogram 18: Spectrogram of question [kədo] in [gʊrmit ne prit nu kɪtab kədo dɪtti?]

In the above spectogram, the words of the sentences are marked on the lowermost tier and the question word [kədo] is highlighted. The acoustic findings for [kədo] are given below.

Table 16: Duration, f0 and amplitude values for [kədo] in Punjabi

Duration	204.8 ms
f0	171 Hz
Minimum amplitude	-0.1 Pa
Maximum amplitude	0.7125 Pa
Difference in Amplitude values	1.7125 Pa

The duration for the question word [kədo] is 204.8 ms. The f0 for the question is 171 Hz whereas the maximum amplitude is 0.7125 Pa. The difference in the maximum and minimum amplitude values is 1.7125 Pa. Let us look at the acoustic findings for the word [kivẽ] below.



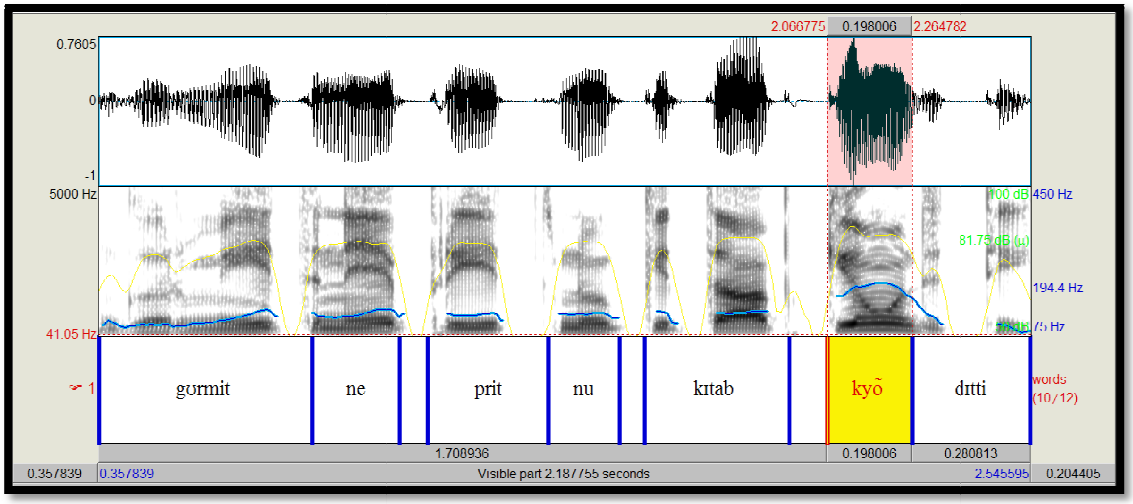
Spectogram 19: Spectrogram of [kɪvẽ] in [gʊrmit ne prit nu kɪtab kɪvẽ dɪtti?]

In the above spectogram, the words of the sentences are marked on the lowermost tier and the question word [kɪvẽ] is highlighted. The acoustic findings for the question word are given below.

Table 17: Duration, f0 and amplitude values for question [kɪvẽ] in Punjabi

Duration	248.4 ms
f0	163.5 Hz
Minimum amplitude	-0.9078 Pa
Maximum amplitude	0.5534 Pa
Difference in Amplitude values	1.4612 Pa

The duration for question word [kɪvẽ] is 248.4 ms. The f0 is 163.5 Hz and the maximum amplitude for the question is 0.5534 Pa. The difference in the maximum and minimum amplitude values is 1.4612 Pa. Let us study the spectogram and acoustic findings for the next question word [kyõ].



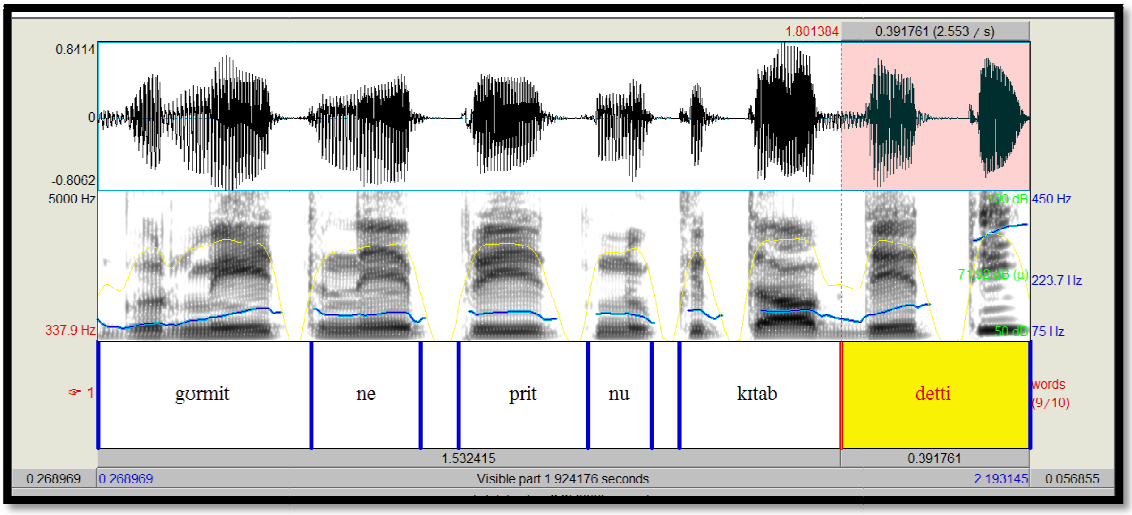
Spectogram 20: Spectrogram of [kyõ] in [gʊrmit ne prit nu kɪtab kyõ dɪtti?]

In the above spectogram, the words of the sentences are marked on the lowermost tier and the question word [kyõ] is highlighted. The acoustic findings for the question word are given below.

Table 18: Duration, f0 and amplitude values for question [kyõ] in Punjabi

Duration	198.1 ms
f0	194.4 Hz
Minimum amplitude	-0.1 Pa
Maximum amplitude	0.7449 Pa
Difference in Amplitude values	1.7449 Pa

The duration for the question word [kyõ] is 198.1 ms. The f0 is 194.4 Hz and maximum amplitude for the question is 0.7449 Pa. The difference in the maximum and minimum amplitude values is 1.7449 Pa. We shall see the acoustic findings for the yes/ no question in Punjabi below.



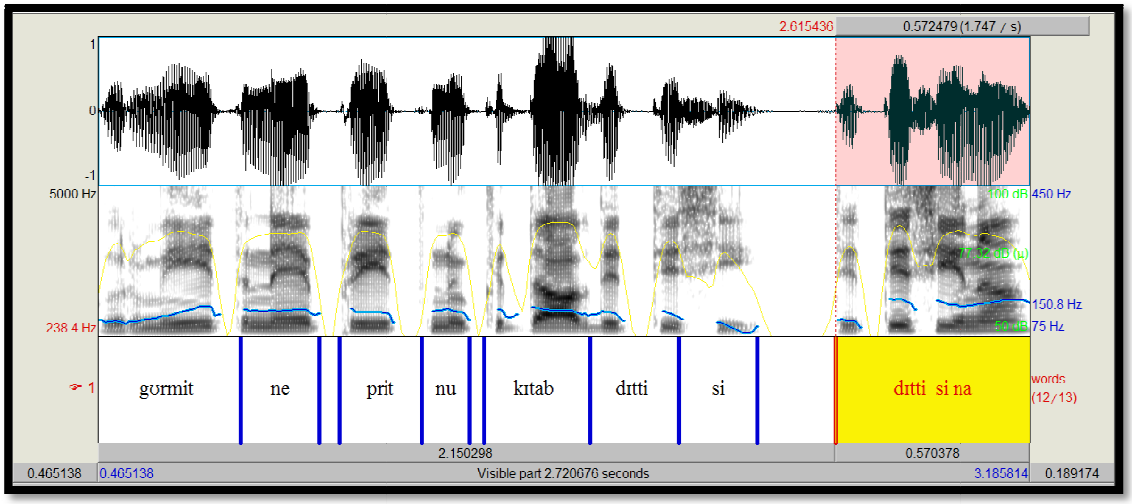
Spectogram 21: Spectrogram of yes/ no question in [gʊrmit ne prit nu kɪtab detti (de dɪtti)?]

In the above spectogram, the words of the sentences are marked on the lowermost tier. Since the participants emphasized the verb mark yes/ no question, it is highlighted. The acoustic findings for the question word are given below.

Table 19: Duration, f0 and amplitude values for yes/ no question

Duration	391.7 ms
f0	223.6 Hz
Minimum amplitude	-0.7586 Pa
Maximum amplitude	0.6620 Pa
Difference in Amplitude values	1.4206 Pa

The duration for the verb in yes/ no question in Punjabi is 391.7 ms. The f0 is 223.6 Hz and maximum amplitude for the question is 0.6620 Pa. The difference in the maximum and minimum amplitude values is 1.4206 Pa. Let us consider the findings for the tag question in Punjabi.



Spectogram 22: Spectrogram of tag question [gʊrmit ne prit nu kɪtab dɪtti si, dɪtti si na?]

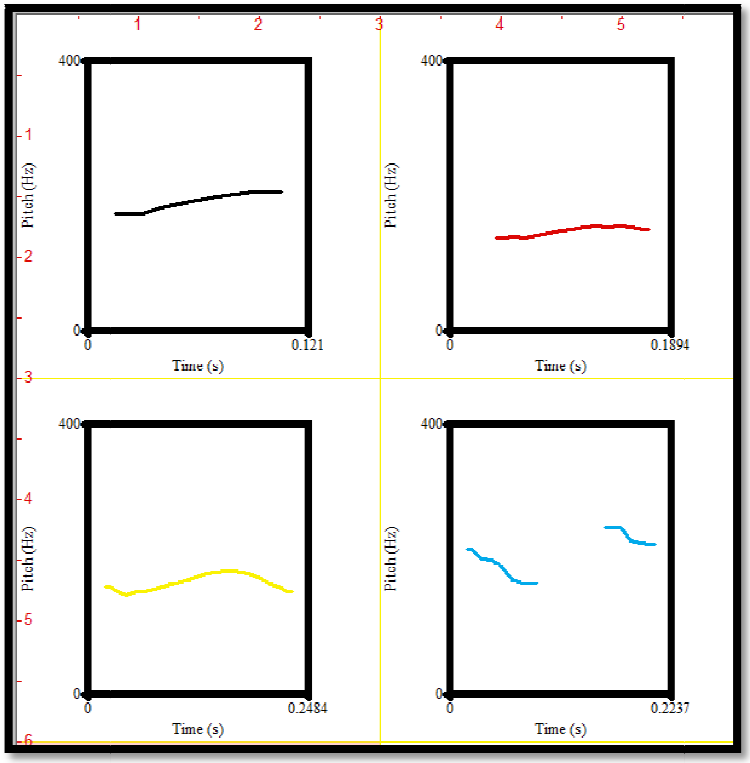
In the above spectogram, the words of the sentences are marked on the lowermost tier and the tag question is highlighted. The acoustic findings for the question word are given below.

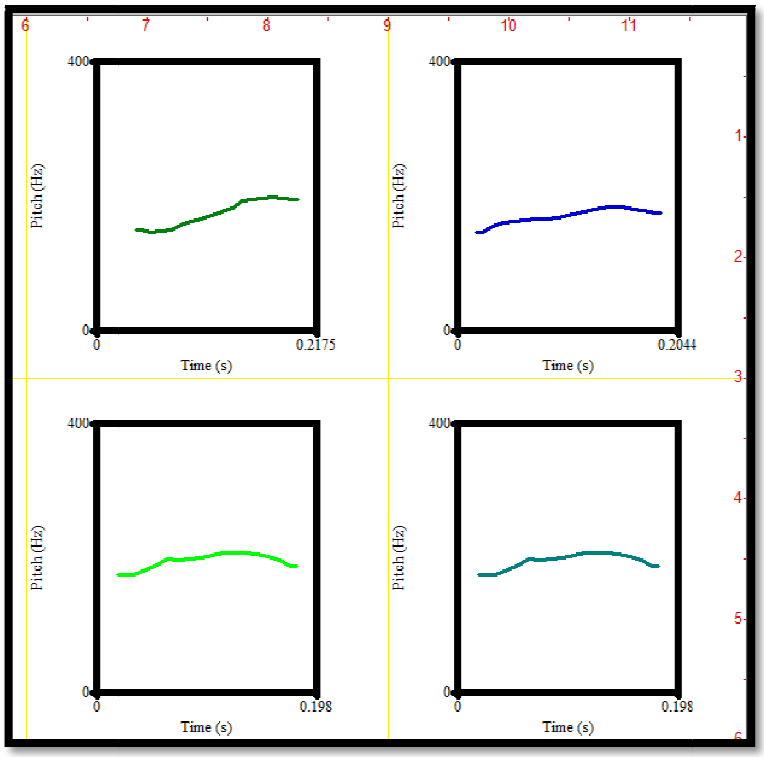
Table 20: Duration, f0 and amplitude values for tag question in Punjabi

Duration	572.4 ms
f0	151.3 Hz
Minimum amplitude	-0.1 Pa
Maximum amplitude	0.7437 Pa
Difference in Amplitude values	1.7437 Pa

The duration for tag question is very high compared to any other question because there are more syllable in this question than in any other. The duration is 572.4 ms. The f0 is 151.3 Hz and the maximum amplitude for the tag question is 0.7437 Pa. The difference in the maximum and minimum amplitude values is 1.7437 Pa.

The pitch diagrams for all the above questions are plotted below.


1
2
3
4
5
400
0
Pitch (Hz)
0
0.121
Time (s)
0.1894
0.2484
0.2237


6
7
8
9
10
11
400
0
Pitch (Hz)
0
0.2175
Time (s)
0.2044
0.198

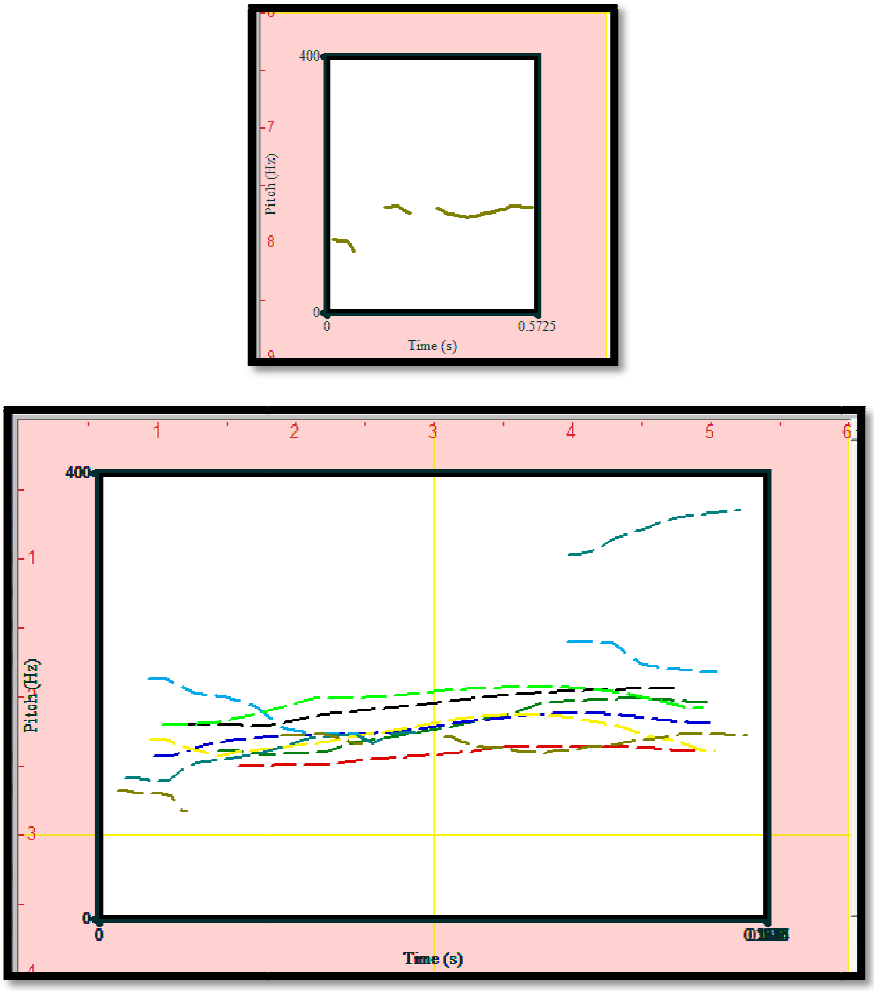


Figure 14: Comparison of pitch movement for different questions in Punjabi

In the above figures, the pitch movements of the question words in Punjabi are shown individually and then all together in one pitch diagram (colors used for each question in the last pitch diagram are mentioned below). The pitch for the questions have different minimum and maximum pitch depending on a lot of factors like the length of the syllables, number of syllables in the word/ question, relevance of the question in the language, etc. The differences in the pitch and other acoustic values for the questions will be compared and discussed below. The colors used for the question words in the last pitch diagram above are mentioned below:

[ki]- black	[kədõ]- blue	[kyõ]- lemon green
[kɪnne]- red	[kivẽ]- yellow tag question- teal	
[kɪnnʊ]- green	yes/ no question- olive	

The table below compares the acoustic findings for the question words in Punjabi.

Table 21: Duration, f0 and amplitude values for various questions

	Duration	**f0**	**Minimum amplitude**	**Maximum Amplitude**	**Diff. in Amplitude values**
ki	121.4 ms	195.2 Hz	-0.4659 Pa	0.3868 Pa	0.8527 Pa
kɪnne	189.3 ms	147.8 Hz	-0.9798 Pa	0.4878 Pa	1.4676 Pa
kɪnnʊ	217.5 ms	195.6 Hz	-0.8594 Pa	0.4959 Pa	1.3553 Pa
kədo	204.8 ms	171 Hz	-1 Pa	0.7125 Pa	1.7125 Pa
kɪvẽ	248.4 ms	163.5 Hz	-0.9078 Pa	0.5534 Pa	1.4612 Pa
kyõ	198.1 ms	194.4 Hz	-0.1 Pa	0.7449 Pa	1.7449 Pa
Yes/ no	391.7 ms	223.6 Hz	-0.7586 Pa	0.6620 Pa	1.4206 Pa
Tag question	572.4 ms	151.3 Hz	-0.1 Pa	0.7437 Pa	1.7437 Pa

The duration of the question [ki] (121.4 ms) is the least among all the questions, probably because of its light weight. The duration of the tag question (572.4 ms) is the most because it has most syllables among all the questions. The f0 is the lowest for question [kɪnne] (147.8 Hz) and the tag question (151.3 Hz). Yes/no question has the highest f0 values (223.6 Hz), followed by for [ki] (195.2 Hz), [kɪnnʊ] (195.6 Hz) and [kyõ] (194.4 Hz) questions. Amplitude gives information about the loudness of the speech sound. The more the amplitude, the louder the speech sound is. The maximum amplitude is highest for tag question (0.7437 Pa), [kyõ] (0.7449 Pa) and [kədo] (0.7125 Pa). Question [ki] has the least maximum amplitude (0.3868 Pa). The difference in the maximum and minimum amplitude values show the rise or fall in the pitch. The more the difference, the steeper the rise/ fall in pitch. The difference in amplitude values is highest for tag question (1.7437 Pa), [kyõ] (1.7449 Pa) and [kədo] (1.7125 Pa) which means the rise in the pitch in these questions is the most. The difference in the amplitude values is the least in [ki] (0.8527 Pa), which means the rise in pitch is least here. The above findings show how the values of acoustic parameters are different in different questions.

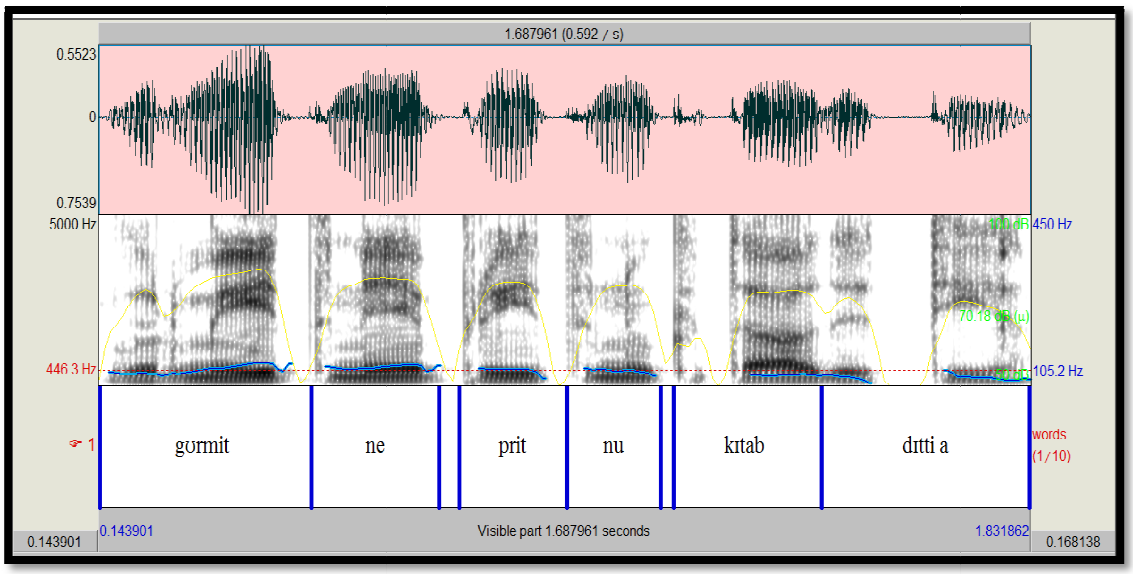
5.2.1.4 Intonation Patterns of Vertical Sentences

After having seen the intonation patterns of various sentences at horizontal level, the intonation patterns of the sentences at vertical level are discussed below. To study the intonation patterns of the sentences at vertical level, the sentence given below will be used.

gʊrmit ne	prit nu	kɪtab	dɪtti a
Gurmeet.erg	Preet to	book	given has

Gurmeet has given a book to Preet.

The acoustic findings of the above sentence spoken with information intonation are given below.



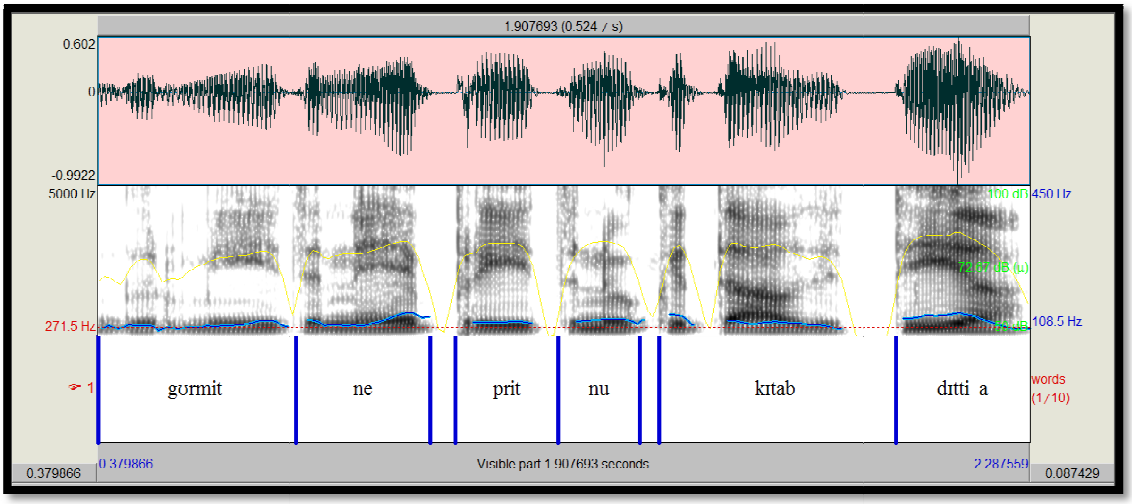
Spectogram 23: Spectrogram showing intonation of simple sentence- information in [gʊrmit ne prit nu kɪtab dɪtti a]

The above spectogram shows the simple intonation on the sentence [gʊrmit ne prit nu kɪtab dɪtti a] and the acoustic findings for the same are mentioned below.

Table 22: Duration, f0 and amplitude values for sentence at vertical level- simple

Duration	1683.4 ms
f0	105.1 Hz
Minimum amplitude	-0.7539 Pa
Maximum amplitude	0.5523 Pa
Difference in Amplitude values	1.3062 Pa

The above spectogram shows the sentence spoken with intonation 'simple'. The duration for the sentence spoken in the simple intonation is 1683.4 ms. The f0 is 105.1 Hz. The maximum amplitude is 0.5523 Pa and the difference in maximum and minimum amplitude is 1.3026 Pa. The acoustic findings of the above sentence spoken with information intonation are discussed below.



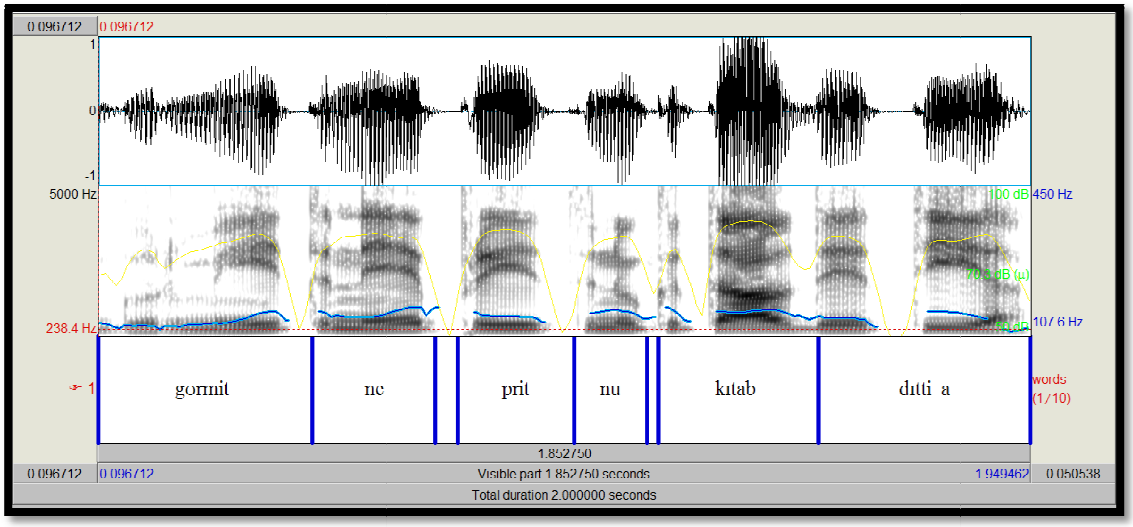
Spectogram 24: Spectrogram showing intonation of vertical sentence- information in [gʊrmit ne prit nu kɪtab dɪtti a]

The above spectogram shows the information intonation on the sentence [gʊrmit ne prit nu kɪtab dɪtti a] and the acoustic findings for the same are mentioned below.

Table 23: Duration, f0 and amplitude values for sentence at vertical level- information

Duration	1903.1 ms
f0	108.2 Hz
Minimum amplitude	-0.9922 Pa
Maximum amplitude	0.6019 Pa
Difference in Amplitude values	1.5941 Pa

The above spectogram shows the sentence spoken with intonation 'information'. The duration for the sentence spoken in the information intonation is 1903.1 ms. The f0 is 108.2 Hz. The maximum amplitude is 0.6019 Pa and the difference in maximum and minimum amplitude is 1.5941 Pa. The acoustic findings of the above sentence spoken with confirmation intonation are discussed below.



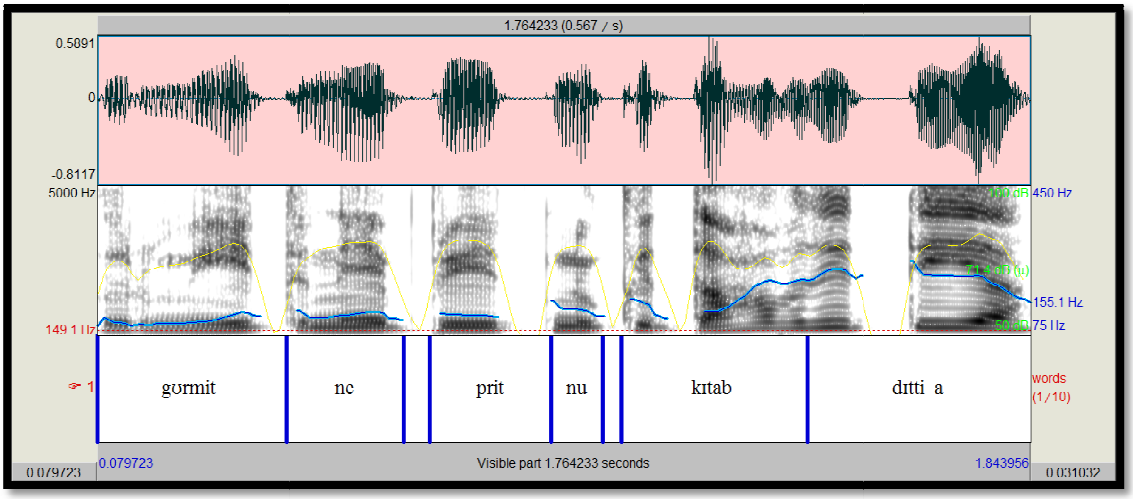
Spectogram 25: Spectrogram showing intonation of vertical sentence- confirmation in [gɔrmit nɛ prit nu kɪtab dɪtti a]

The above spectogram shows the confirmation intonation on the sentence [gɔrmit nɛ prit nu kɪtab dɪtti a] and the acoustic findings for the same are mentioned below

Table 24: Duration, f0 and amplitude values for sentence at vertical level- confirmation

Duration	1858.7 ms
f0	122.5 Hz
Minimum amplitude	-1 Pa
Maximum amplitude	0.5890 Pa
Difference in Amplitude values	1.5890 Pa

The spectogram above shows the sentence spoken with 'confirmation' intonation. The duration for 'confirmation' intonation is 1858.7 ms and the f0 is 122.5 Hz. However the maximum amplitude for the sentence spoken with confirmation intonation (0.5890 Pa) is lesser than the maximum amplitude for the information sentence (0.6019 Pa). The difference in amplitude values in confirmation sentence is 1.5890 Pa. The acoustic findings of the above sentence spoken with exclamation intonation are discussed below.



Spectogram 26: Spectrogram showing intonation of vertical sentence- exclamation in [gʊrmit ne prit nu kɪtab dɪtti a]

The above spectogram shows the exclamation intonation on the sentence [gʊrmit ne prit nu kɪtab dɪtti a] and the acoustic findings for the same are mentioned below

Table 25: Duration, f0 and amplitude values for sentence at vertical level- exclamation

Duration	1782 ms
f0	154.9 Hz
Minimum amplitude	-0.8117 Pa
Maximum amplitude	0.9999 Pa
Difference in Amplitude values	1.8116 Pa

The duration for the sentence spoken with exclamatory intonation is 1782 ms and the f0 is 154.9 Hz. Maximum amplitude for the exclamatory sentence is 0.9999 Pa) and the difference in the amplitude values of exclamatory sentence is 1.8116 Pa. Let us take a look at the pitch movements of the sentence spoken with simple, confirmation, information and exclamation intonation below to draw some generalizations.

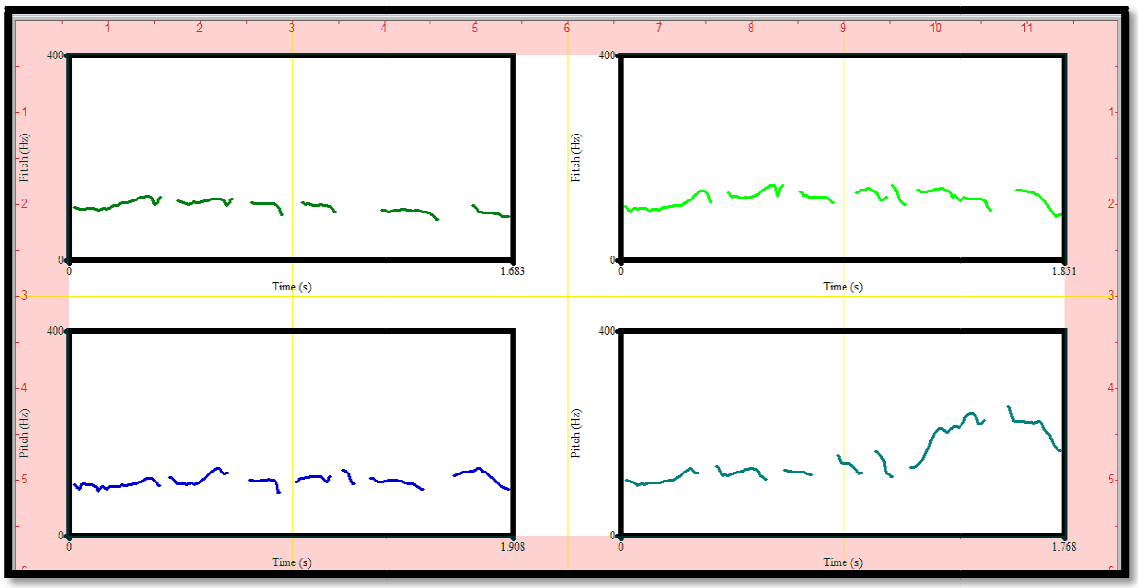


Figure 15: Pitch movements for sentence [gʊrmit ne prit nu kɪtab dɪtti a] spoken in vertical level- simple (green), information (blue), confirmation (lemon green), and exclamation (teal)

The above pitch diagrams show the pitch of the sentence [gʊrmit ne prit nu kɪtab dɪtti a] spoken with three different intonations- confirmation, exclamation and information. One can see that the pitch goes high in the middle of the sentence in information and exclamation intonated sentences whereas in case of sentences spoken with

confirmation intonation, the pitch goes high at the beginning and at the end of the sentence. Sentence with exclamation intonation has the highest maximum pitch of all, which is due to the surprise/ exclamation in the intonation. The acoustic findings for the sentence [gʊrmit ne prit nu kɪtab dɪtti a] in information, confirmation and exclamation vertical intonations are given below.

Table 26: Duration, f0 and amplitude values for sentence [gʊrmit ne prit nu kɪtab dɪtti a] spoken in vertical level (confirmation, exclamation and information)

	Simple	**Information**	**Confirmation**	**Exclamation**
Duration	1683.4 ms	1903.1 ms	1858.7 ms	1782 ms
f0	105.1 Hz	108.2 Hz	122.5 Hz	154.9 Hz
Minimum amplitude	-0.7539 Pa	-0.9922 Pa	-1 Pa	-0.8117 Pa
Maximum amplitude	0.5523 Pa	0.6019 Pa	0.5890 Pa	0.9999 Pa
Difference in Amplitude values	1.3062 Pa	1.5941 Pa	1.5890 Pa	1.8116 Pa

The above findings reveal that the maximum amplitude for the sentence spoken with confirmatory intonation (0.0950 Pa) is lower than the maximum amplitude of sentence spoken with other intonations. This means the sentence with confirmatory intonation is spoken softer compared to other sentences. Also, the difference in the minimum and maximum amplitude values is least in confirmatory sentence (0.2369 Pa). The difference is vast in case of information sentence (0.2908 Pa) which means there is steep rise in amplitude of sentence spoken with this intonation. The difference in the amplitude values for exclamation sentence is 0.2592 Pa. The duration for speaking the sentence is least with simple intonation (1683.4 ms), followed by for exclamation intonation (1782 ms) whereas the duration for sentence with confirmation (1858.7 ms) and information (1903.1 ms) intonation are highest. The above findings prove that there are different vertical intonation levels for any sentence.

5.2.2 Generalizations

It is observed that, in horizontal declarative sentences, the f0 and maximum amplitude values are more for all constituents (subject, direct object, indirect object and verb) when emphasized and the difference in maximum and minimum amplitude values were greater for the emphasized constituents in comparison to their non-emphasized counterparts. The duration values are consistently lower for emphasized constituents in comparison to non-emphasized constituents.

It is observed that the maximum amplitude values are highest for order sentences, followed by in simple sentences and the maximum amplitude values are found to be the least in requests. Also, the difference between the maximum and minimum amplitude values is the widest in order sentences which means that in order sentences, there is more amplitude change compared to the simple and request sentences. The difference in maximum and minimum amplitude values is observed to be lowest in request sentences. The f0 values are found to be the highest for simple sentences whereas the f0 values are almost same for request sentences and for order sentences. The duration is the highest in request sentences and the least in order sentences.

The duration of the question [ki] (121.4 ms) is the least among all the questions, probably because of its light weight. The duration of the tag question (572.4 ms) is the most because it has most syllables among all the questions. The f0 is the lowest for question [kɪnne] (147.8 Hz) and the tag question (151.3 Hz). Yes/no question has the highest f0 values (223.6 Hz), followed by for [ki] (195.2 Hz), [kɪnnʊ] (195.6 Hz) and [kyõ] (194.4 Hz) questions. Amplitude gives information about the loudness of the speech sound. The more the amplitude, the louder the speech sound is. The maximum amplitude is highest for tag question (0.7437 Pa), [kyõ] (0.7449 Pa) and [kədo] (0.7125 Pa). Question [ki] has the least maximum amplitude (0.3868 Pa). The difference in the maximum and minimum amplitude values show the rise or fall in the pitch. The more the difference, the steeper the rise/ fall in pitch. The difference in amplitude values is highest for tag question (1.7437 Pa), [kyõ] (1.7449 Pa) and [kədo] (1.7125 Pa) which means the rise in the pitch in these questions is the most. The difference in the amplitude values is the least in [ki] (0.8527 Pa), which means the

rise in pitch is least here. The above findings show how the values of acoustic parameters are different in different questions.

The above findings reveal that the maximum amplitude for the sentence spoken with confirmatory intonation (0.0950 Pa) is lower than the maximum amplitude of sentence spoken with other intonations. This means the sentence with confirmatory intonation is spoken softer compared to other sentences. Also, the difference in the minimum and maximum amplitude values is least in confirmatory sentence (0.2369 Pa). The difference is vast in case of information sentence (0.2908 Pa) which means there is steep rise in amplitude of sentence spoken with this intonation. The difference in the amplitude values for exclamation sentence is 0.2592 Pa. The duration for speaking the sentence is least with simple intonation (1683.4 ms), followed by for exclamation intonation (1782 ms) whereas the duration for sentence with confirmation (1858.7 ms) and information (1903.1 ms) intonation are highest. The above findings prove that there are different vertical intonation levels for any sentence.

5.3 Conclusion

Punjabi is a prosodically rich language. In this chapter, tones in Punjabi were discussed and the rules for predicting its type and placements were posited. It is seen in the chapter that the correct placement and type of tone can be correctly predicted in Punjabi and that it is dependent on the placement of accent and the placement of voiced aspirated consonant in orthography of the word. It is also seen that duration, f0 and amplitude values are the acoustic cues to tones in Punjabi. Moreover, studying the pitch diagrams gives a clearer idea of the type of tone present on the syllable/ word. It must be noted that assuming tones are not present in the underlying forms, would not lead to natural and accurate explanation of the occurrences of tone. Hence the present work assumes that tones are present in the underlying form. It will else be impossible to predict the exact location and nature of occurrence of tones.

The various intonation patterns for Punjabi were shown and the comparisons between different horizontal and vertical level realizations were made using acoustic cues- duration, f0 and amplitude values. It is claimed in the present study that maximum

amplitude and difference in the maximum and minimum amplitude values is a strong cue to studying intonation patterns in Punjabi. It is observed that the same sentence can be spoken with different intonations in Punjabi which changes the acoustic measurements for the utterances. The intonations of several questions in Punjabi were studied using a sentence. The intonation of constituents with emphasis and with simple intonations was compared. Also, the intonation of different imperatives- order and request were compared with the intonation of a simple sentence. It was observed that the study of intonation could give us a lot of information about the prosody of Punjabi language. It conveys linguistic as well as paralinguistic meanings in conversation. In the next chapter, the concepts- schwa deletion and nasalization will be discussed.

CHAPTER 6

ASPECTS OF PUNJABI PHONOLOGY III

This chapter deals with the various phonological problems in Punjabi. It is argued that the problems may appear phonological in nature but these problems are emerging at the interface of phonology and morphology. The present work aims at explaining some phonological problems in Punjabi language by providing an explanatorily adequate and less costly explanation within the (non-linear) prosodic framework. Therefore, the prosodic elements along with the phonological processes will help in providing an adequate solution to the problems like schwa deletion and nasalization. The problem of schwa deletion will be discussed in the first section of the chapter and the problem of nasals and nasalization will be studied in the second section. The phonological problems of glide insertion, /y/-/j/ alternation and the occurrence of geminates in Punjabi will be discussed in the third, fourth and fifth sections respectively.

6.1. Schwa Deletion at phonology-morphology interface

Schwa deletion comprises an important area in the phonology of Punjabi. Schwa [ə] is the only vowel which is not visible in orthography of Punjabi overtly, hence, there is some ambiguity and indetermination with respect to its pronunciation in the language. The phonological-morphological factors determine whether the schwa vowel will be pronounced or not. It is important to understand the environments where it is deleted and where it is retained. Schwa is often pronounced as short [a] in Punjabi. The present work will give a brief review of the points noted by scholars and thereafter, take phonological-morphological factors into consideration for explaining this process in Punjabi.

The transcription in this section uses the transcription as used by the scholars themselves. Jain (1934) looks at the problem of schwa deletion diachronically. Sharma (1971) gives a contrastive account of how differently the words are pronounced in Hindi and Punjabi languages and observes that there is a tendency to produce some Hindi words without schwa in Punjabi, however, he has not made any generalizations or given any rules. Srivastava (1974) takes into account the

description given by Sharma (1971) and claims that the schwa preceding a heavy syllable gets deleted (p. 74). Kalra (1982) states that it appears from Singh (1979) that the schwa deletion is observed in the speech of the rural and/or illiterate speakers and in informal speech (p. 72). Kalra (1982) claims that schwa, when non-accented, gets deleted in Punjabi, if the phonotactic constraints do not block application of this rule (p. 124-125). Bhatia (1993) state that the schwa deletes in Punjabi when a vowel suffix is added to it, eg. [kukkəɽ] 'chicken' + [ã] = [kukkɽã] (p. 349). Sethi (1997) proposes that the schwa in non-accented environment is deleted in Hindi, if it is preced by syllable carrying accent (p. 156). The rules proposed in the present work to account for schwa deletion have been borrowed from Sethi's work on Hindi. Singh (2004) state that the process of schwa deletion is common in the Punjabi, and that schwa in the final syllable gets deleted when affix is added to the word, eg. [kə.ˈbu.tər] becomes [ka.ˈbu.tri] and [ˈpɪn.jər] becomes [ˈpɪn.jra] on affixation (p. 60-61). Singh and Lehal (2011) have given 11 rules to predict occurence and deletion of schwa in Punjabi. However, he neither took into account the concepts of syllable nor accent. Singh and Lehal (2012) reports that every consonant in Punjabi is followed by schwa, the schwa after the first consonant is retained and all others are deleted. Kaur and Singh (2014) give four rules for predicting the retainment or deletion of schwa for transliteration purposes, however, they don't take into consideration the process of syllable.

In general, there is a tendency to delete schwa in languages (wherever possible) in fast and casual speech to speed up the communication process (Lupyan and McClelland, 2003). It reduces the number of syllables in the word, total duration and makes the articulation of words easier. Over a period of time, the words with schwa deletion replace the older words, without schwa deletion, and the sociolinguistic process becomes a diachronic phenomenon (Singh & Lehal, 2010). There are words in Punjabi that show alternation with respect to schwa deletion like [ə.ˈkal] ~ [ˈkal] 'famine', [ˈwaj] ~ [ə.ˈwaj] 'voice/ sound', [sə.ˈval] ~ [ˈsval] 'question', however, the present work will concentrate on the schwa deletion observed due to affixation processes, like [ˈən.dər] 'inside' > [ˈən.drõ] 'from inside', [ˈcə.rəs] 'drug' > [ˈcər.si] 'drug addict', etc. Therefore schwa deletion as a grammatically conditioned entity will be studied in the present work.

The present work aims to discover the environment in which schwa deletion can take place, on affixation. It is important to take into account the concept of syllable and accentuation in the context of phonological-morphological interface in order to predict schwa deletion in Punjabi.

6.1.1 Results

Schwa deletion is a productive process in Punjabi and is found to be triggered by the process of affixation which changes the prosodic structure of the word. The present work proposes that the problem of schwa deletion can be accounted for by taking into account accentuation.

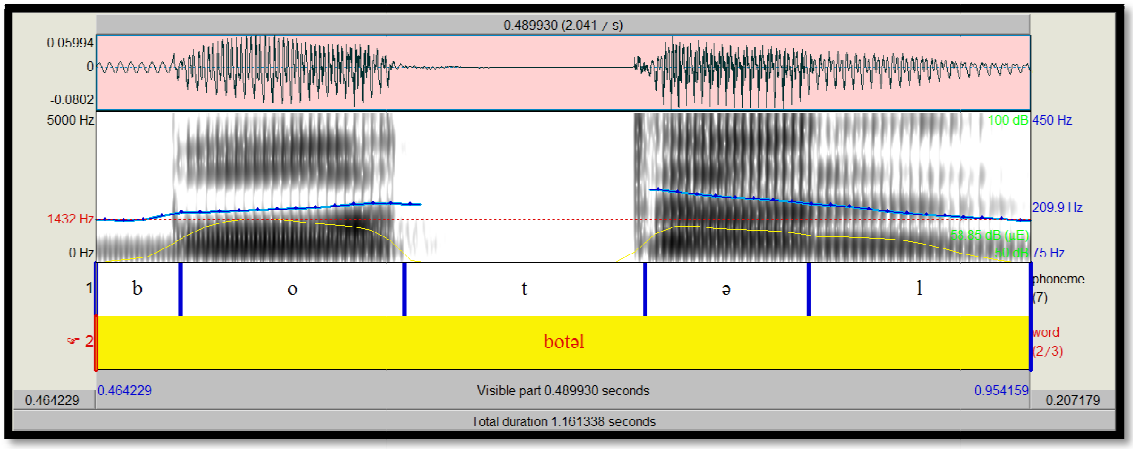
6.1.1.1 Schwa deletion in words on affixation

Consider the examples below that show how the syllable structure changes on affixation in Punjabi.

Schwa Deletion in Punjabi		
suffix –ã for pluralization		
ˈa.dət	ˈad.tã	habbits
ˈgər.dən	ˈgər.dnã	neck.plural
ˈpʊt.tər	ˈpʊt.trã	sons
ˈpət.tʰər	ˈpət.tʰrã	stones
ˈbo.təl	ˈbot.lã	bottles
ˈnə.zər	ˈnəz.rã	sight/ view (plural)
suffix –i for making adjective		
ˈhja.mət	ˈhjam.ti	barbering
ˈga.jər	ˈgaj.ri	carrot color
ˈme.nət ~ ˈme.ɳət	ˈmen.ti ~ ˈmeɳ.ti	hard working
ˈgə.rəm	ˈgər.mi	heat
ˈka.gəj	ˈkag.ji	paperwork
ˈa.ləs	ˈal.si	lazy

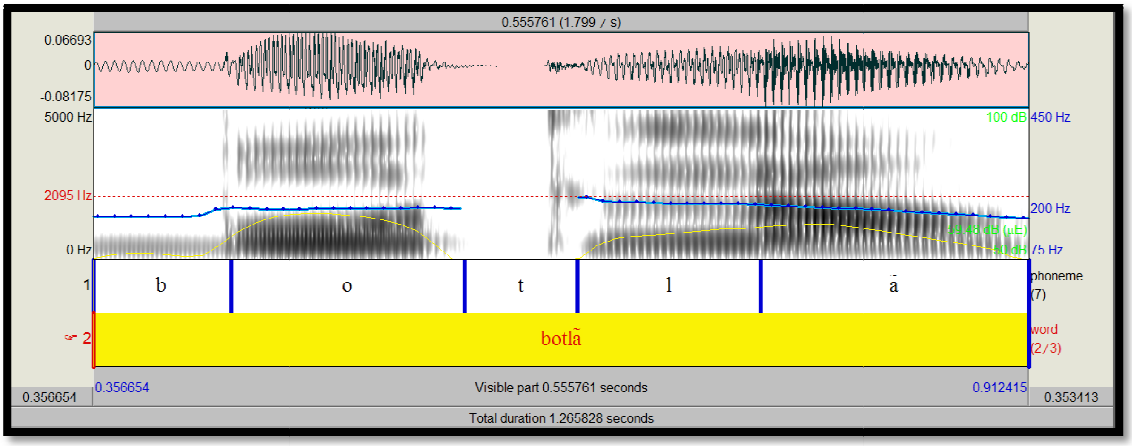
ˈkʰə.bər	ˈkʰəb.ri	reporter
ˈji.vən	ˈjiv.ni	biography
ɪ.ˈma.rət	ɪ.mar.ti	monumental
ˈki.mət	ˈkim.tɪ	expensive
ˈfɪ.ləm	ˈfɪl.mi	filmy
suffix –õ for location 'from'		
jə.ˈlən.dər	jə.ˈlən.drõ	from Jalandhar
ˈən.dər	ˈən.drõ	from inside
ˈɛd.dər	ˈɛd.drõ	from here
ˈdəf.tər	ˈdəf.trõ	from office
ˈji.gər	ˈjig.rõ	from the heart
suffixes for making abstract noun		
ˈəs.əl	ˈəs.lɪ.yət	reality
ˈje.hər	ˈjeh.rɪ.la	poisonous
ˈno.kər	ˈnok.ri	job

It is observed in the above examples that there is change in syllabic structure and deletion of schwa in the root word on affixation. The change in syllable structure of the word [botəl] after affixation is discussed below.



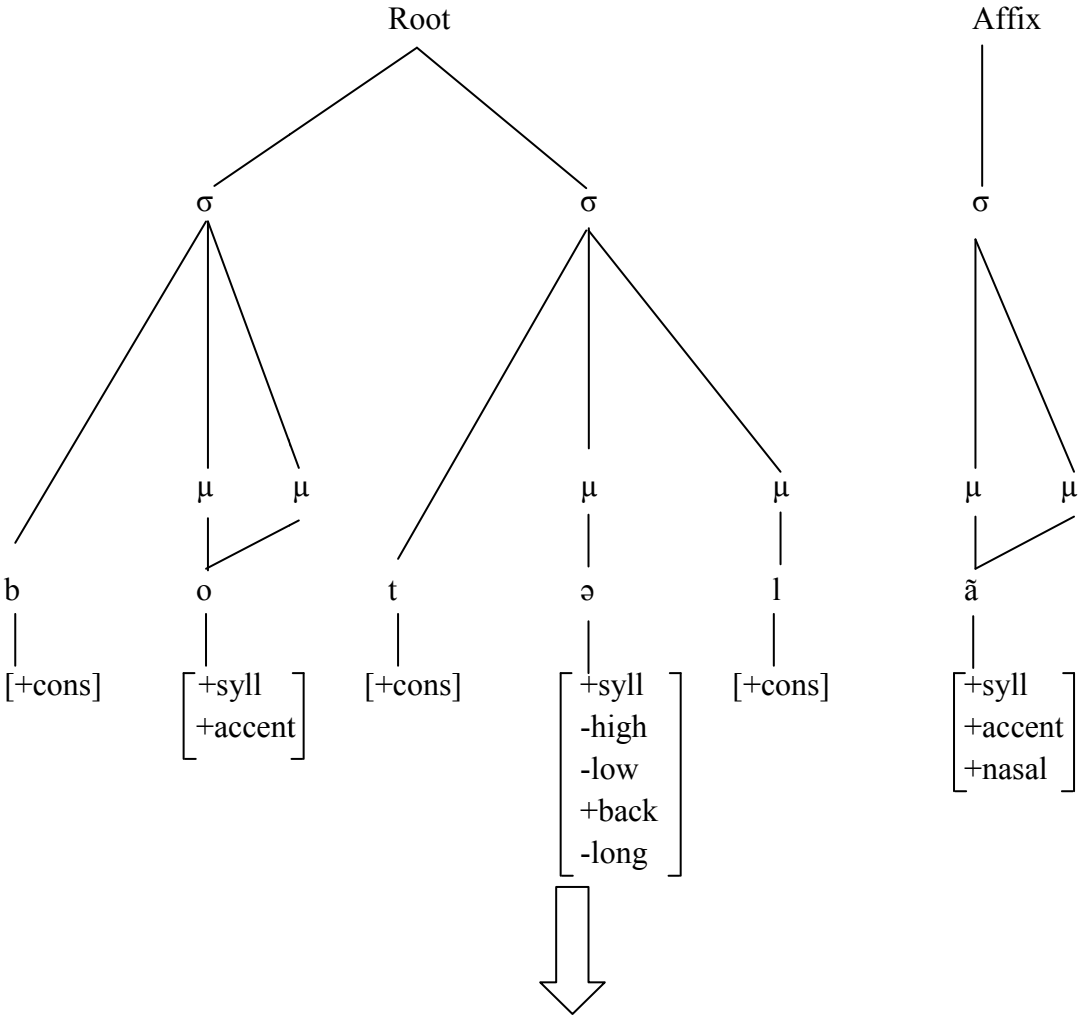
Spectogram 27: Spectrogram showing the presence of schwa in [botəl]

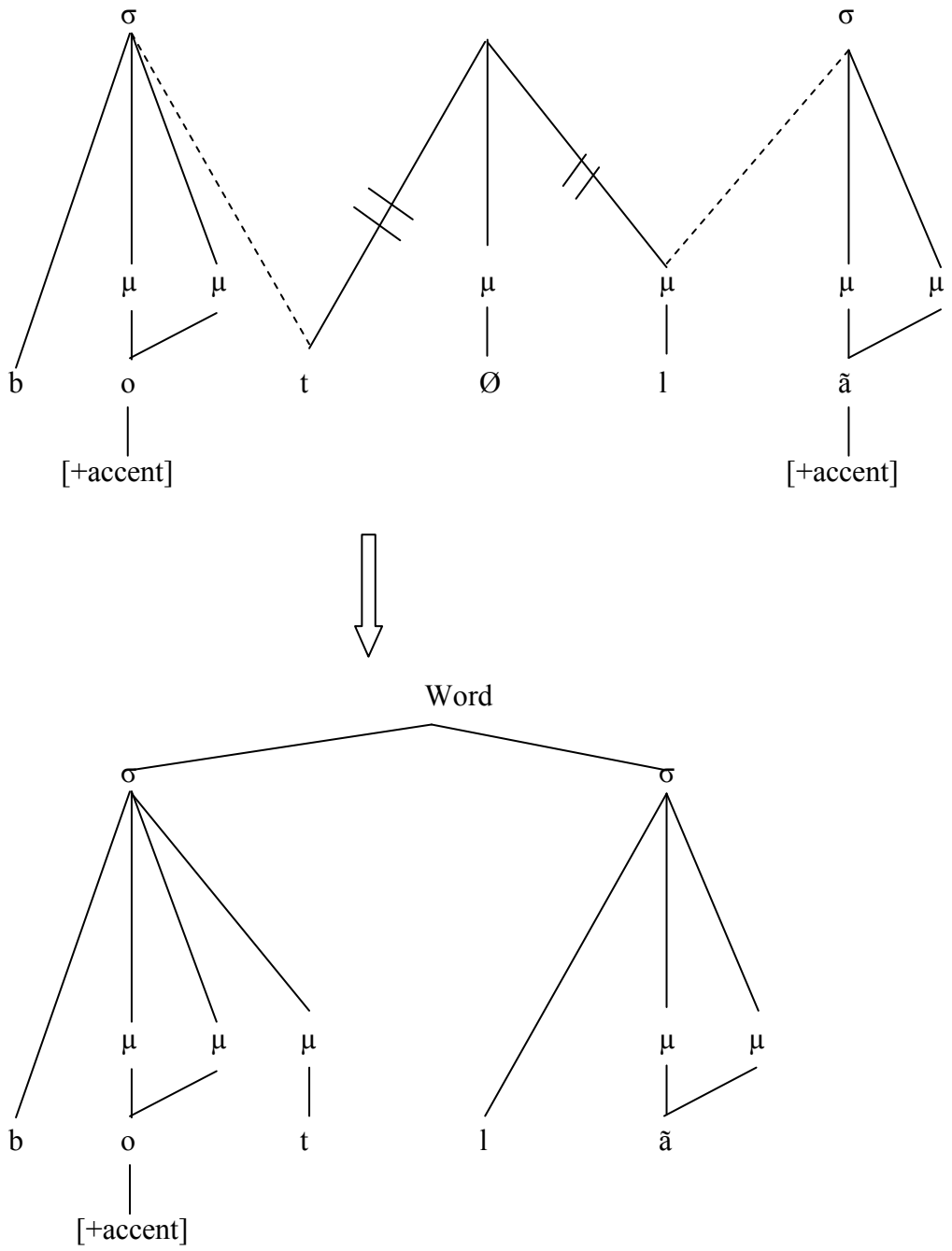
The above spectogram shows the presence of schwa in the word [botəl] in Punjabi.



Spectogram 28: Spectrogram of [botlã]

It is observed that the schwa is not present in the above spectogram which was earlier present in the word before affixation. Let us look at the representation of the words to understand the process of schwa deletion on affixation.





Since, schwa is not accented and its deletion will not lead to phonotactic constraints, it gets deleted in step one. Onset of the syllable with schwa delinks with its syllable and forms another link with the preceding syllable as coda of that syllable. In the next step, the onset of the syllable with schwa gets resyllabified and becomes the coda of the preceding syllable. Rules of accentuation apply again and only one syllable gets the accent in the final word. It is to be noted here that if schwa precedes the accented syllable such as in [də.ˈmag] 'brain', [jə.ˈmiŋ] 'land', [sə.ˈval], schwa will not be

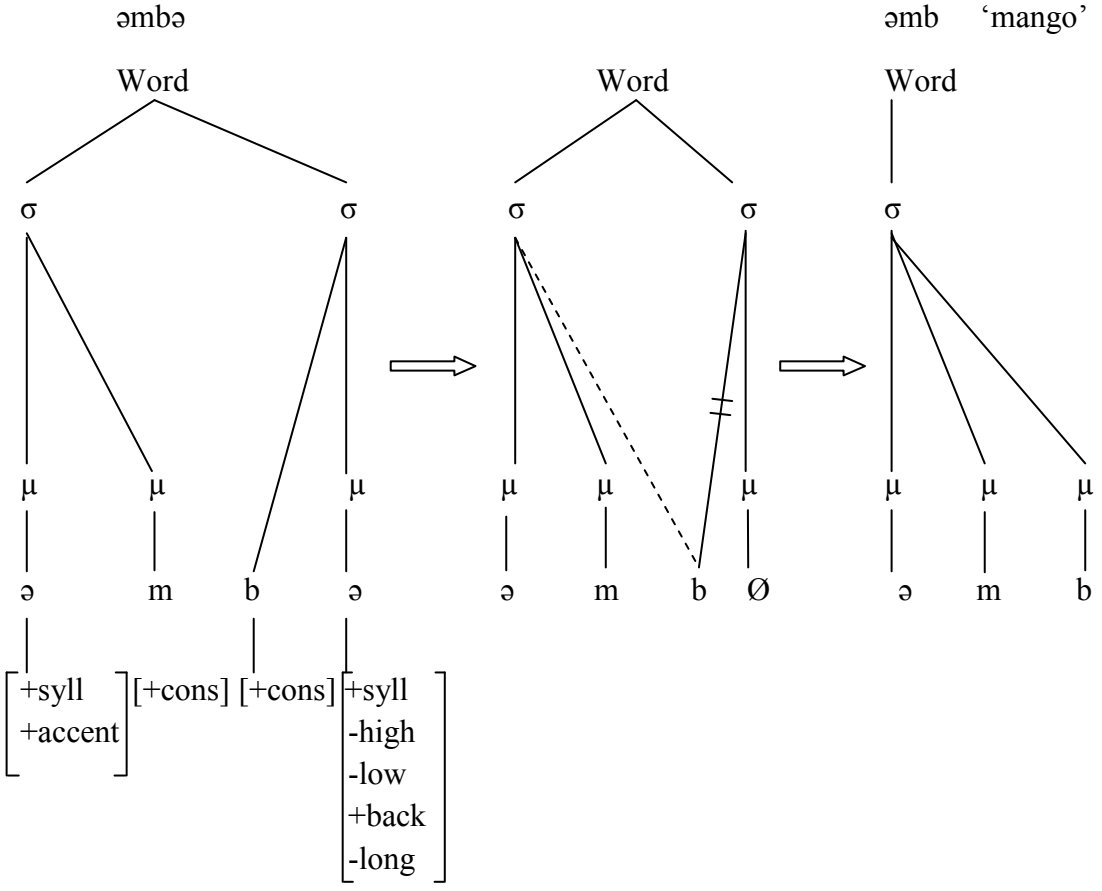
deleted on affixation. Also, if schwa is accented either in the final word or before affixation, it is not deleted.

6.1.1.2. Word-final Schwa Deletion

Consider the examples given below with respect to word final schwa:

Word-final Schwa			
Sanskrit	Prakrit	Punjabi	Gloss
kərɳə	kəɳɳə	ˈkənn	ear
cərmə	cəmmə	ˈcəmm	skin
amrə	əmbə	ˈəmb	mango
gʰəɳʈa	gʰəɳʈa	ˈkəɳ.ʈa	bell
ləbdʰə	labʰə	láb	profit

It is observed in the above examples that the word final schwa present in Prakrit is never accented and hence deleted in Punjabi language. The representation below shows the same.



6.1.1.3. Generalization

It is seen above that schwa deletion happens on affixation if the accented syllable precedes the schwa and if schwa is accented neither in the final word nor in the morpheme before affixation. It is further noted that schwa deletion rule is applied only to bisyllabic words. The present work proposes the rule stated below for schwa deletion in Punjabi on the basis of the observation made above.

Rule of Schwa Deletion in Punjabi

a) Schwa gets deleted after affixation of a heavy syllable if schwa follows the syllable bearing accent. If the coda position of the accented syllable is empty, onset of the syllable with schwa becomes coda of the preceding syllable.

b) Schwa present in word final position in Prakrit is deleted in Punjabi language.

6.2. Nasal Consonant Formation and Vowel Nasalization

Nasalization is an important supra-segmental and distinctive feature of Punjabi. However, it is also one of least understood concepts. Many scholars have attempted to account for the presence and working of nasals in Punjabi but most of these are phonological studies. Jain (1934) states that nasal geminates have evolved from historically present homorganic nasals followed by voiced consonants in Punjabi. Srivastava (1970) has categorized nasals into: nasıkyə (nasal segment/ mutes), ənʊsvarə (homorganic nasal) and ənʊnasıkə (nasalized vowel). Srivastava claims that nasal archisegments are realized on the basis of syntagmatic relations and occur only in V__CV environment. According to Kalra (1982), Srivastava (1970) claims that homorganic nasals and nasalized vowels are a result of loss of nasal archisegment in Punjabi (p. 130). Ohala and Ohala (1991) claim there is a strong tendency for [ṼNC] when the consonant is voiced but for [ṼC] when the consonant is voiceless in Hindi (p. 219). Ohala (1991) claim that nasalization, in Hindi, is because of the influence of historically present nasal consonants. For example, Sanskrit [dəntə] is [dãt] ‘tooth’ in Hindi. She also mentions that Ohala (1983) proposes that an intrusive nasal consonant intervenes if a long nasalized vowel is followed by a voiced consonant as in [cãnd] ‘moon, but there will be no nasal consonant if the consonant following the long

nasalized vowel is voiceless as in [dãt] 'tooth' (p. 117). She further explain that the consonant clusters found in Middle Indo-Aryan like 'cəndə' simplified and appeared as 'cãdə' in Old Hindi and then finally as 'cãnd' in Modern Hindi. However, Hindi underwent the stages of simplification of clusters and vowel lengthening, Punjabi did not, hence, the MIA words [dənda] and [cənda] are realized as [dənd] and [cənd] in Punjabi. Kalra (1982) claims that, in Punjabi, nasal segments occur in V_V environments or word initially, and nasal archisegments occur in V_CV environments only (p. 162). Kalra (1982) also states that vowel nasalization is stronger if the vowels are long and/ or preceding the nasal consonant (p. 146-147).

The transcription in this section uses the transcription as used by the scholars themselves. Some scholars who have worked on nasalization in Punjabi claim that the nasalization in Punjabi is progressive. Jain (1934) states that the vowels following nasal consonants are nasalized. Bahl (1975) also proposes that the vowels following the nasalized vowel are nasalized. Bhatia (1993) claims that the vowels following nasal consonants nasalize if they have mid or high tone, eg. [nã] 'name' (p. 347). However, other scholars have proposed regressive nasalization in Punjabi. Clivio (1966) suggests that the direction of nasalization is regressive. Sharma (1971) has proposed that phonologically conditioned nasalization as in [cãⁿdi] 'silver', [tãᵐba] 'copper' and phonotactically conditioned nasalization which is observed on a vowel preceding a nasal consonant are regressive nasalization. Bhatia (1993) proposes that all the vowels preceding nasal consonants nasalize in Punjabi, if there no intervening consonant, eg. [cə̃n] 'moon' (p. 347). Singh (2004) states that the word-final long vowels are nasalized and if the last long vowel is stressed, then the preceding short vowel is nasalized, eg [rə̃ˈgai] 'colouring', [mə̃ˈga] 'demand.causative' (p. 63-66). Bahri (1969), on the other hand, has claimed that nasalization in Dogri is phonemic and also unpredictable (p. 96). He has listed the various environments in which the vowels nasalize (p. 97-99). For eg. [mənnĩ] 'agreed upon', [kĩnnã] 'how much', [də̃nd] 'tooth'. Similarly, Malik (1995) has given examples of both progressive and regressive nasalizations. He proposes that the vowel preceding the nasals get nasalized strongly, however, the vowels following the nasals get weakly nasalized, eg. [əɳmãɳ] 'estimate', [bımar] 'sick', [hərãm] 'illegitimate'. He,

however, doesn't mention how the degree of nasalization was observed. He proposes that a homorganic nasal stop is present between nasalized vowel and the following stop, eg. [denda] 'giving', [ʃərmında] 'ashamed'. Gill and Gleason (2013) too states that the vowels get nasalized in the vicinity of nasal consonants (p. 37)- without mentioning the direction of nasal spread. Therefore, the scholars have not given a clear picture of nasal spread in Punjabi.

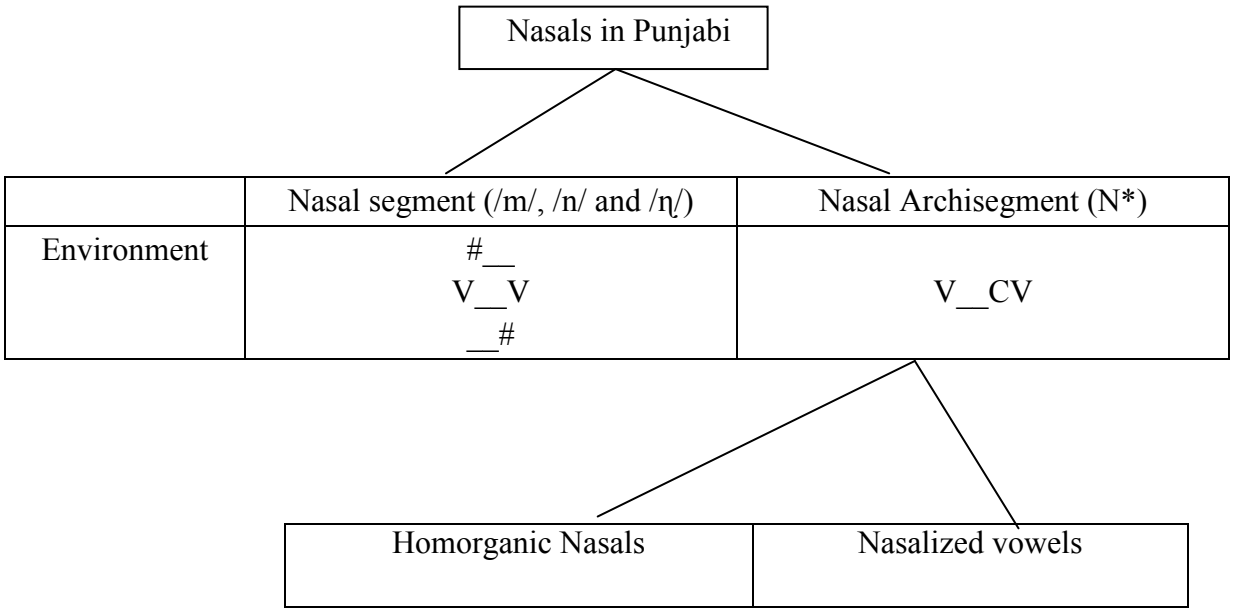
Clivio (1966) proposes that all the long vowels may show nasalization in word final positions in Punjabi, eg. [kyõ] 'why', [tũ] 'you'. Arun (1997) has given examples of only nasalized vowels, eg. [ũth] 'camel', [jãvãga] 'shall go + masculine'. Sharma (1971) has also given examples of pure nasalization (syllabically conditioned) in words like [gã] 'cow', [rũ] 'cotton', [phãsi] 'hanging', which are nasalized vowels realized without any nasal consonant. Bahri (2011) has listed examples of nasalized vowels, eg. [g̃ã] 'cow', [m̃ãm̃ã] 'uncle' and [d̃ãn] 'donation. He claims that only long vowels show nasalization (p. 9-10).

Some scholars have posited that the vowel nasalization is because of the presence of a nasal consonant in the underlying form of the word. Jain (1934) considers that the vowel nasalization in Punjabi is result of nasal consonant in the underlying form which gets deleted either historically or because the nasal was part of the unstressed syllable. Ferguson (1963) considers it to be a result of loss of nasal archisegment (p. 59) while Ohala (1978) proposed it to be because of loss of nasal segment in Hindi (p. 25). However some scholars have posited a nasal vowel in the underlying form. Sethi (1997: 137) and Klopfenstein (2006) propose that positing a nasal vowel in the underlying form as opposed to the oral vowel would give a very complicated analysis of Hindi and Ottawa languages.

6.2.1. Nasal Segment and Archisegment

The present work believes that there are three nasal segments, /m/, /n/ and /ɳ/, present word-initially (eg. [nak] 'nose'), word-finally (eg. [gʊɳ] 'qualities') and intervocalically (eg. [jana] 'to go') in the underlying form of Punjabi, along with a nasal archisegment. Archisegments are conditional sound segments which are

realized differently as per the neighboring environment. The present work believes there is a nasal archisegment as these occur in specific environment as mentioned below and show assimilation with the following consonant, hence it would not be economical to assume all possible nasal realizations in the underlying form. The three nasal segments are present in Prakrit, hence it would be more natural and economical to assume these segments in the underlying form. This nasal archisegment, present in V__CV environment, further leads to the surface realization of vowel nasalization and/ or homorganic nasals, depending on the context. The representation below shows the above mentioned:



The various ways in which nasal archisegment is realized in the surface form in Punjabi are discussed below.

6.2.2. Direction of Assimilation in Punjabi

There is a strong tendency to nasalize vowels in VN contexts (preceding vowel) in the language. Punjabi language has a great tendency permitting only regressive assimilation. Zahid (2010) explains as to why vowels in VN contexts nasalize stronger than in NV context. “For the vowels in VN context, the velum started to lower from the onset of the vowels to allow coupling between the oral and nasal cavities making the vowel to adopt +nasal feature. So the nasality gradually increased

from onset to the offset of vowels following nasal consonants /n, m, ŋ/. Inversely, velum lowered from onset to the offset of vowels in NV context allowing greater coupling between oral and nasal cavities at the onset of the vowel. So the nasality gradually decreased from onset to the offset of the vowels preceding nasal consonants." So, the direction of assimilation for every case in Punjabi will be regressive.

It is to be noted here that vowel nasalization is an example of assimilation. Oral vowels assimilate with the following nasal consonants as nasals are stronger than oral vowels, according to strength hierarchy. Strength hierarchy will be discussed in section 6.4.

6.2.3. Homorganic Nasals

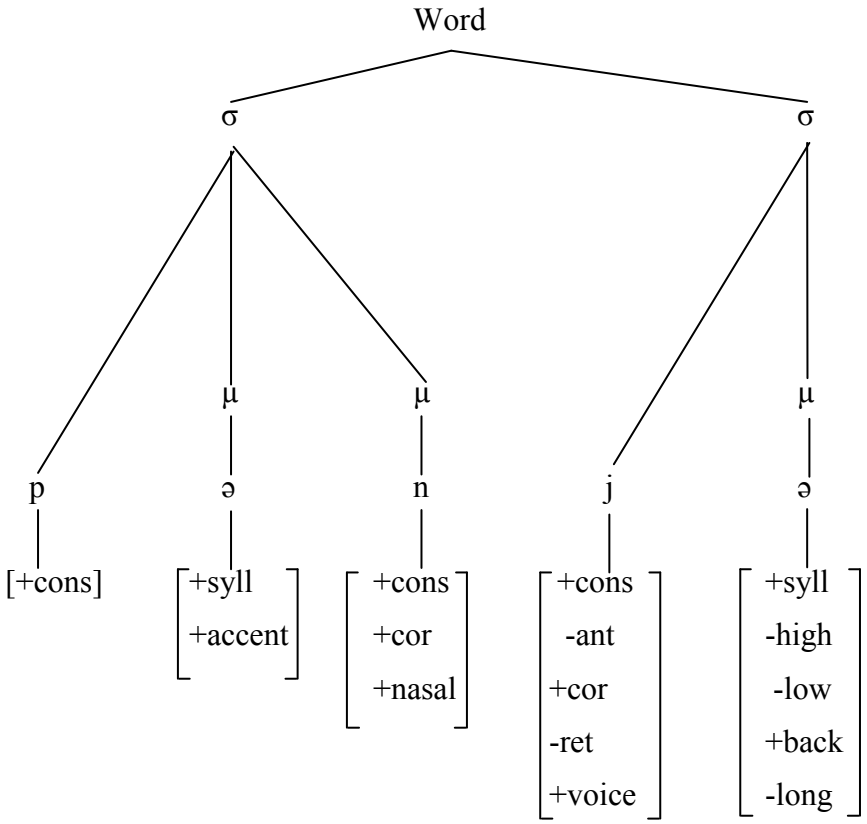
The examples of pre-consonantal homorganic nasals in Punjabi are given below. One must pay attention to the placement of accent in the examples below to understand the process.

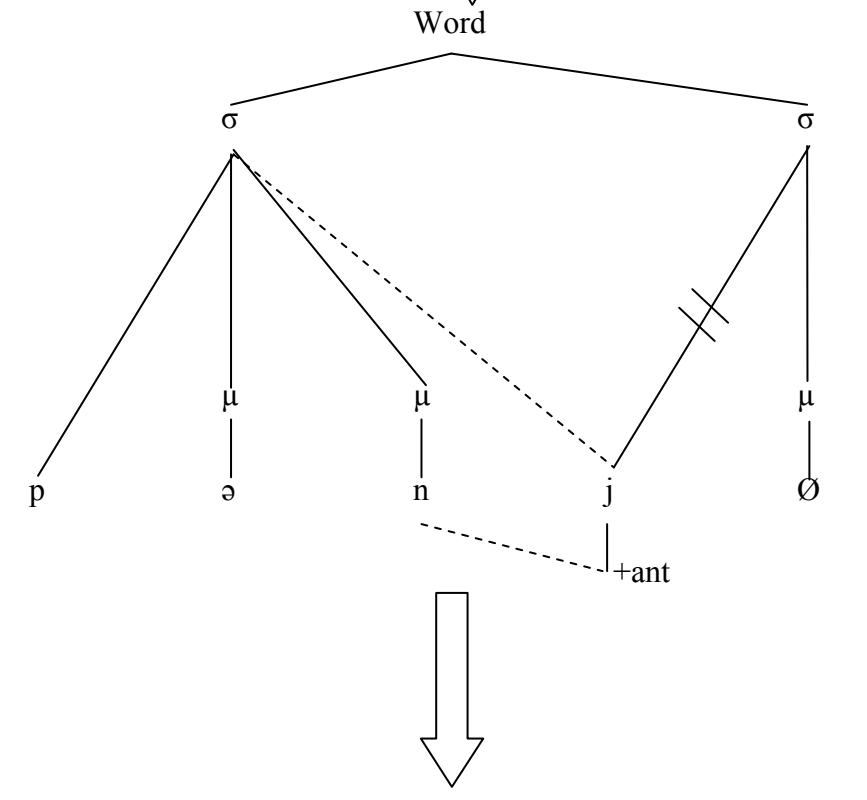
Examples of Pre-consonantal Homorganic Nasals			
Sanskrit	Prakrit	Punjabi	Gloss
pənjə	pəmcə	ˈpəɲj	five
amrə	əmbə	ˈəmb	mango
ɖəntə	dəmtə	ˈdənd	tooth
gʰəɳʈa	gʰəɳʈa	ˈkəɳ.ʈa	bell
pəɳɖɪtə	pəmɖiə	ˈpəɳ.ɖət	saint
jani	jãji (Latin)	ˈjəɲj	assembly for marriage

(Prakrit vocabulary has been taken from *A Comparative Dictionary of the Indo—Aryan Languages* by Turner)

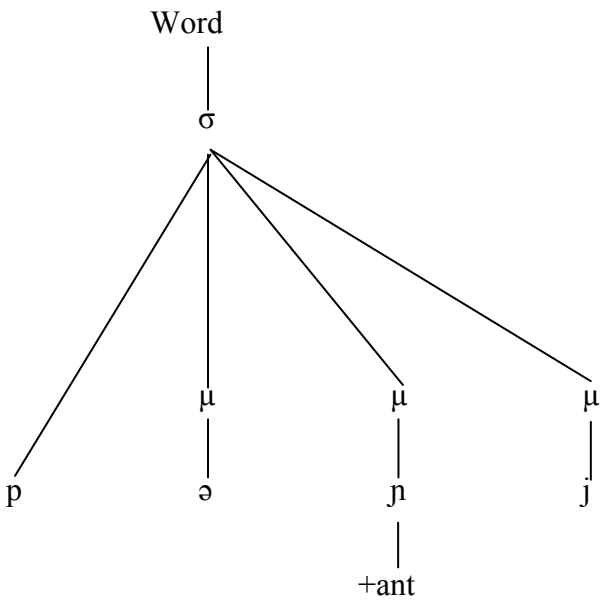
It is observed that the nasal archisegment is part of the accented syllable in all the examples and the peak of the syllable is a short vowel. In the light of above, one can say that homorganic nasals in the surface realization are found when the nasal archisegment is present in accented syllable with light peak in the underlying form. The representation below shows regressive assimilation of place of articulation in the word below.

pənjə (Sanskrit) ‘five’

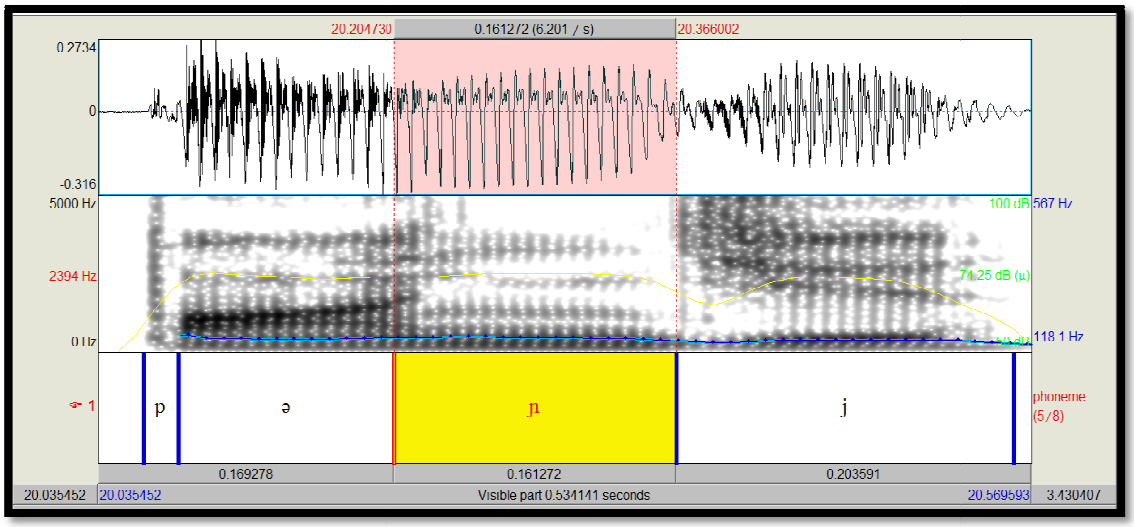




pəɲj (Punjabi) ‘five’



In the first stage, rule of word-final schwa deletion applies because of which resyllabification takes place and the onset of the syllable with schwa becomes the coda of the preceding syllable. There is regressive assimilation of the place of articulation so the nasal consonant becomes [+anterior] in the above word. The spectogram for the word is shown below.



Spectogram 29: Spectogram of [pəɲj]

The above spectogram shows the presence of nasal consonant in the word [pəɲj].

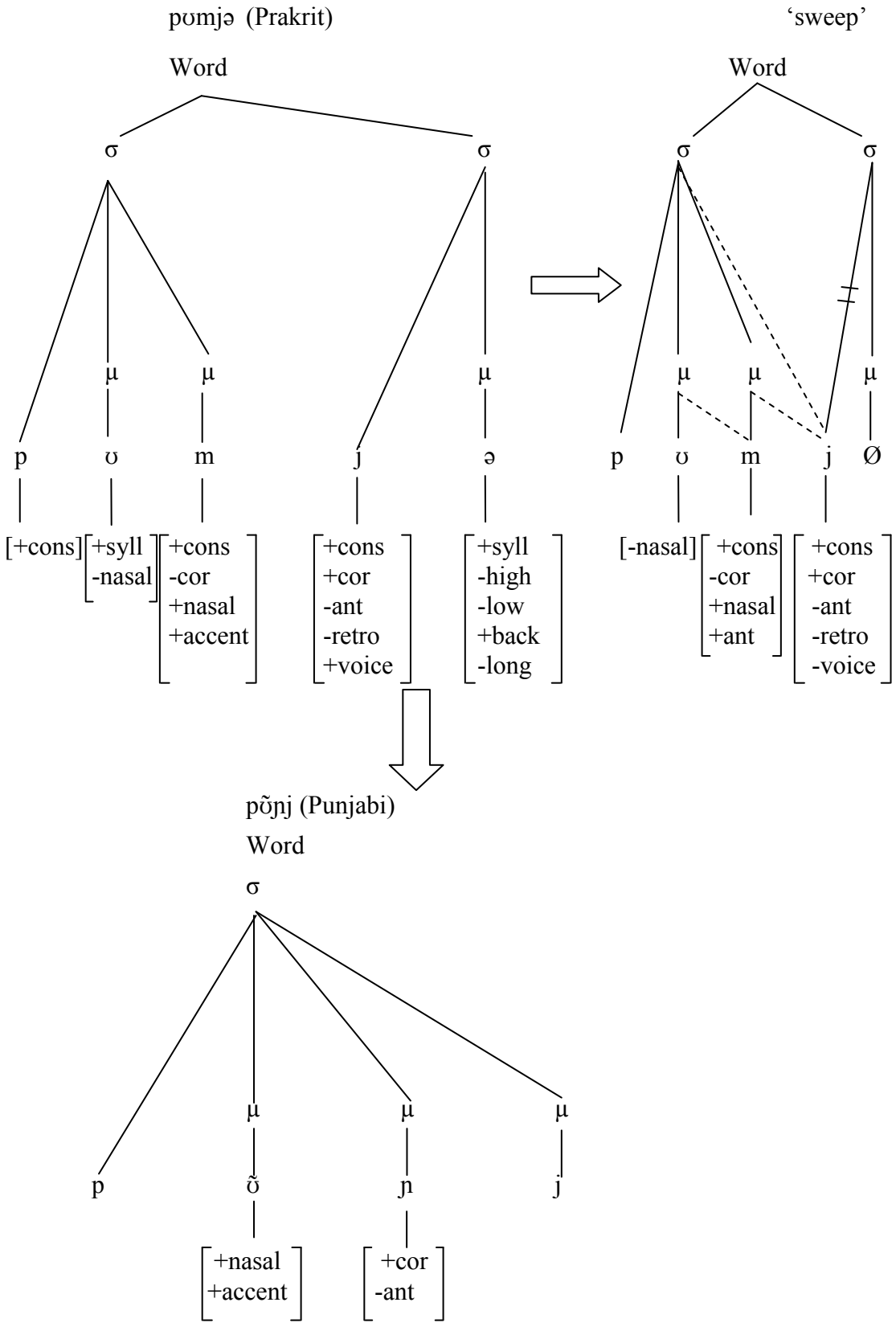
6.2.4. Vowel Nasalization and Homorganic Nasals

The present work believes that nasalized vowels are not present in the underlying form since it would be uneconomical to assume all the vowels with their nasalized counterparts in underlying form. The vowels are nasalized only in the environment of nasal segments or archisegment, hence there is specific environment for nasalized vowels. Let us see examples of long vowels in the environment of nasal archisegments.

Examples of Vowel Nasalization and Pre-consonantal Homorganic Nasals			
Sanskrit	Prakrit	Punjabi	Gloss
cãdi	cəmdia	ˈcãn.di	silver
aʊɽəɳʊ	agʊnga	ˈgũŋ.ga	dumb
proncʰəti	pʊmjə	ˈpũɲj	sweep
kəndʊkə	gemdʊə	ˈgẽnd	ball for playing

(Prakrit vocabulary has been taken from *A Comparative Dictionary of the Indo—Aryan Languages* by Turner)

All the long vowels in the table above show nasalization before nasal archisegment. The above long vowels before the nasal archisegment show vowel nasalization and there is no deletion of nasal consonant, instead the nasal consonant assimilates with the following consonant and forms homorganic consonant. The representation below explains the same.


pʊmjə (Prakrit)
'sweep'
Word
Word
σ
σ
σ
σ
μ
μ
μ
μ
μ
μ
p
ʊ
m
j
ə
p
ʊ
m
j
Ø
[+cons]
[+syll
-nasal]
[+cons
-cor
+nasal
+accent]
[+cons
+cor
-ant
-retro
+voice]
[+syll
-high
-low
+back
-long]
[-nasal]
[+cons
-cor
+nasal
+ant]
[+cons
+cor
-ant
-retro
-voice]
põɲj (Punjabi)
Word
σ
μ
μ
μ
p
õ
ɲ
j
[+nasal
+accent]
[+cor
-ant]

Word final schwa deletes in the first step and the features of nasal consonant spread to preceding vowel. Also, the nasal consonant takes the place of articulation features from the following consonant.

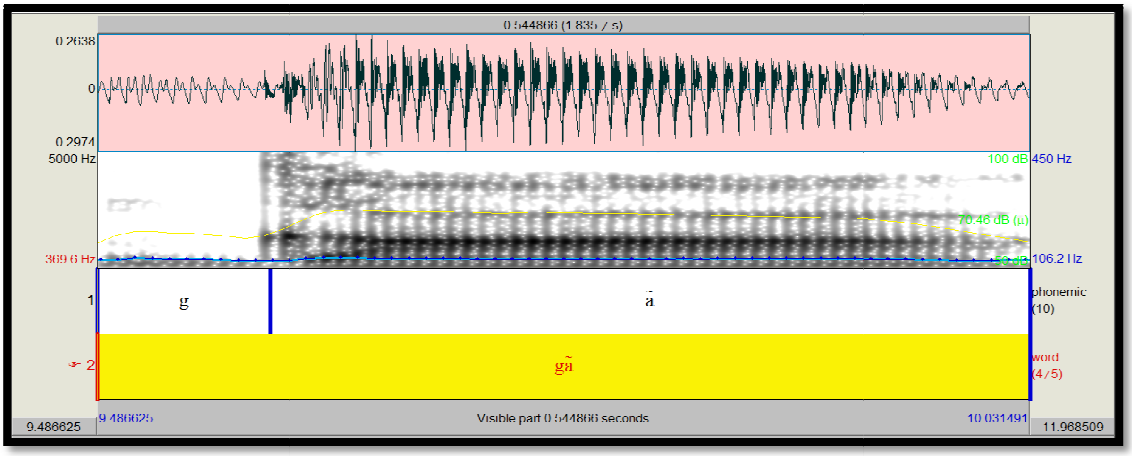
6.2.5. Exceptions

Let us see the examples of Punjabi words which have word final vowel nasalization, however there is no nasal consonant in the word final position on the surface.

Word final vowel nasalization	
Surface Form	Gloss
gã	cow
kʊɽɪyã	girls
tʰã	place
lũ	hot wind
tʊã	smoke
lokã	people

(Some of the words in the above table have tones, which have not been marked to focus on nasalization)

Let us see spectogram of one of the above words to see if there is any nasal consonant in the word final position.



Spectogram 30: Spectogram showing absence of nasal consonant in gã

The above spectogram shows there is no nasal consonant present in the word final position in the word gã, however, there is nasalization of the word final vowel.

To account for examples like above, Grierson (1961) claims that a study of historical linguistics doesn't give evidence for presence of nasalization, hence he called these as

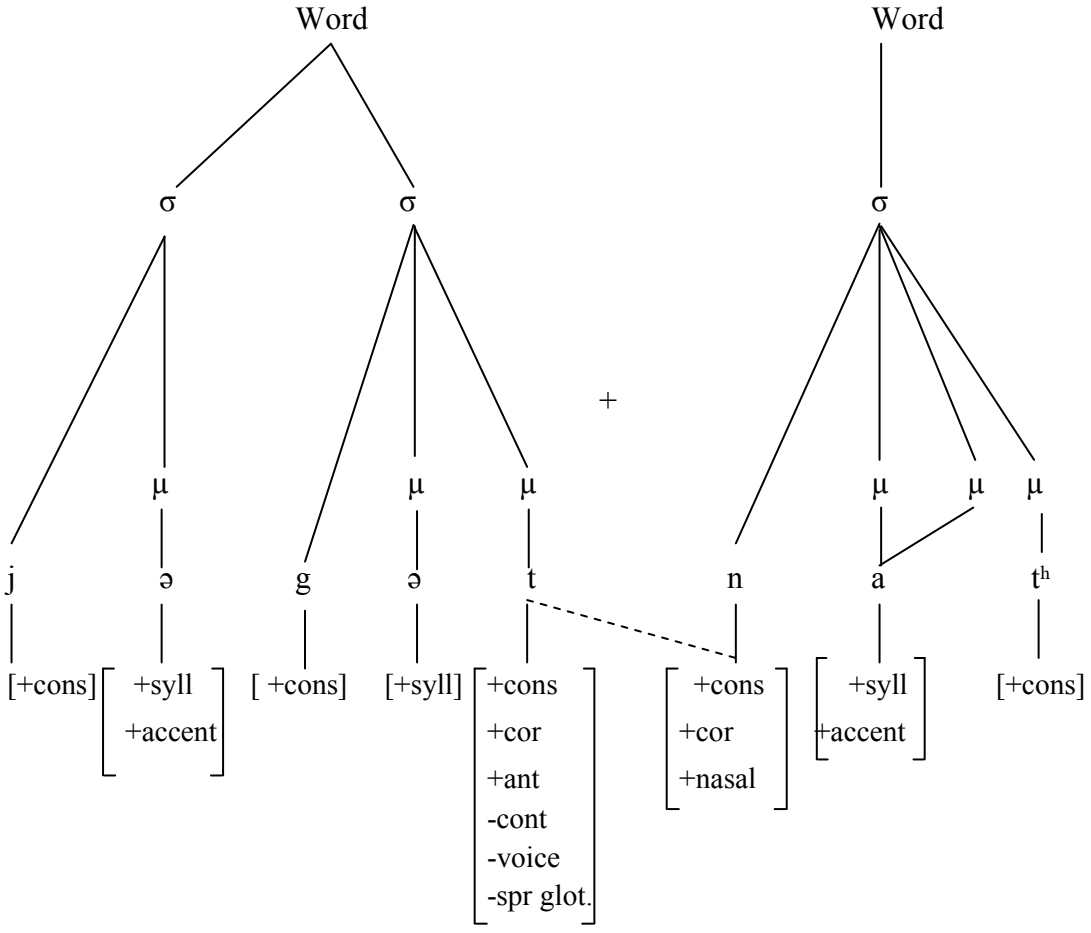
examples of spontaneous nasalization. Jain (1934) has also called these as cases of spontaneous nasalization and Kalra (1982) states "… in the absence of any plausible correlation between these segments and nasalization, such cases can be safely called "spontaneous nasalization" (p. 161). Hence the above mentioned examples will be stated to be examples of spontaneous nasalization as historically there is no nasal consonant observed in examples such as above.

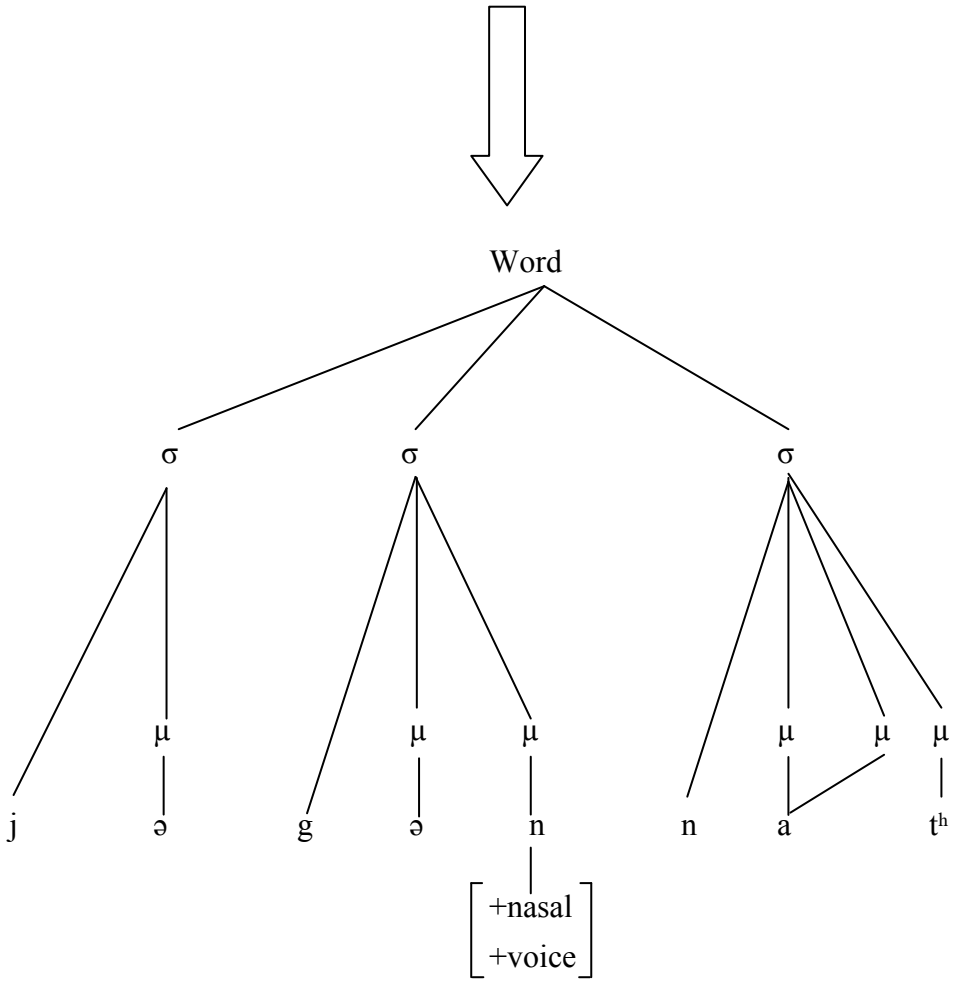
6.2.6. Assimilation across boundary

When two morphemes combine to form a new word, some modification takes place. For example:

jəgət + nat^{h} ⟶ jə.gən.nath 'a name'

Partial regressive assimilation also happens when morpheme adds and there is a nasal consonant at the word final position of the first word or a nasal consonant at the word initial position. The representation below shows the same.





The above representation shows that when morpheme [natʰ] adds to the word [jəgət], regressive assimilation is observed at the interface. Similarly, səm.toʃ satisfaction' becomes sən.toʃ, səm.sar 'world' becomes sən.sar, səm.jog 'chance' becomes 'sən.jog' and cıt.me 'a name' becomes cın.me.

Assimilation takes places in a word to reduce its complexity thereby making the articulation of the word easy. When regressive assimilation takes place in a word, the articulation of the words gets easier.

6.2.7. Generalizations

On the basis of the observations made above, the following generalizations are formed. The generalizations made below are similar to the ones proposed by Kalra (1982) in his work on nasalization.

1. There are three nasal segments and a nasal archisegment in the underlying forms in Punjabi.
2. If the nasal archisegment is a part of accented syllable, it becomes a homorganic nasal and assimilates with respect to the place of the articulation with the following consonant.
3. The nasal archisegment spreads its nasality to preceding vowel except in case of accented short vowel.
4. The nasal archisegment gets deleted if it is part of the non-accented syllable.

Rule of Nasalization of Vowels: Nasal archisegment assimilates with the following consonant and spreads it nasality to preceding vowel except in case of accented short vowel. Nasal archisegment gets deleted after spreading its nasality to short non-accented vowel.

6.3. Rule of Glide Insertion in Punjabi

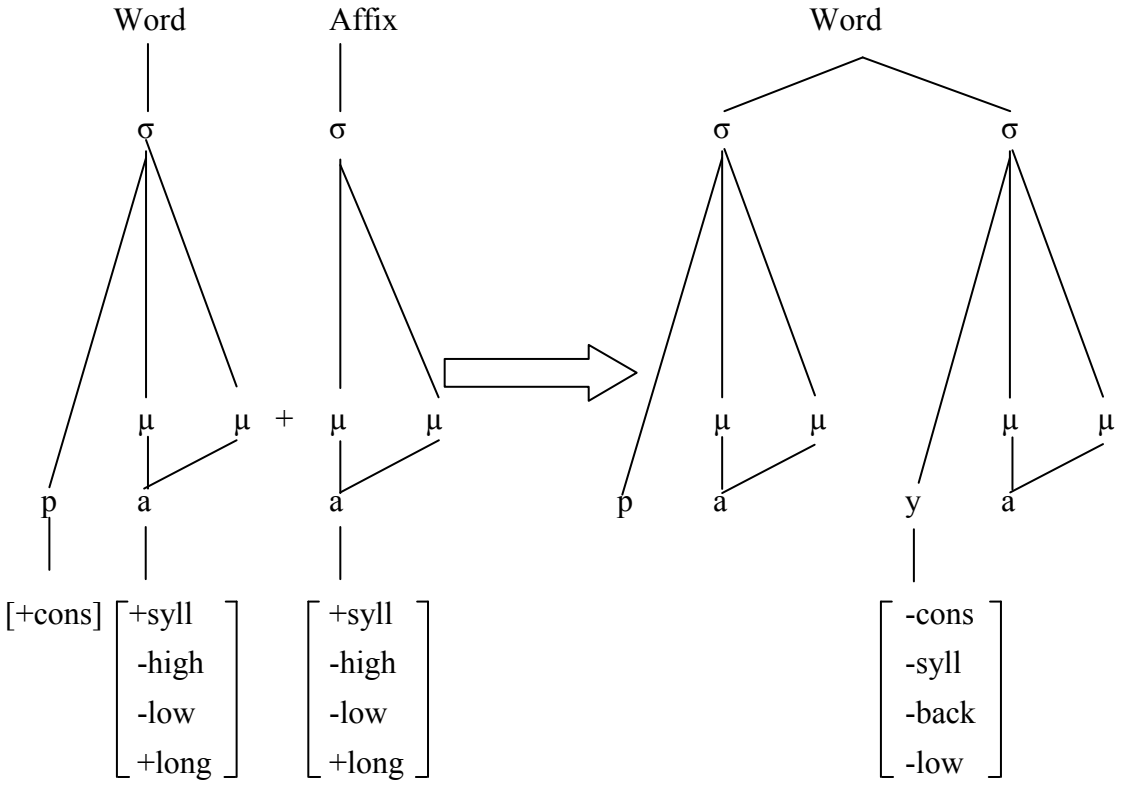
Let us look at examples of glide insertion below:

Examples of Glide Insertion			
Root word	Affix for past perfect	Spoken Variety	Gloss
so	a	soya	slept
pa	a	paya	found
a	a	aya	came
ga	a	gaya	sang
səmj^{h} (understood)	a	sə́mjaya	explained

In the above examples, there is formation of vowel cluster on addition of suffix in all the above examples. One can clearly see above that there is insertion of /y/ in such cases. Gill and Gleason (1969) stated that glides occur between vowels and Kalra (1982) too state that there is insertion of glides in vowel sequences (Kalra, 1982, p. 192, 200). The present work proposes that glide is inserted when two morphemes join

to form a vowel sequence. Hence, glides are not present in the underlying form of the word and are added on the surface form. The glide insertion rule is stated below:

Glide Insertion Rule: There is insertion of glide at the phonology-morphology interface between two vowels coming together due to morphological processes.



The above representation shows the insertion of glide between a vowel sequence.

6.4. Alternation of high front glide /y/ with the back palatal voiced /j/

With respect to glides, one can also see alternation between /y/ and /j/ sounds in Punjabi. Consider the examples given below to understand the same:

Alternation of high front glide /y/ with the back palatal voiced /j/		
yʊg	jʊg	era
yog	jog	union
yəhã	jəhã	here
yəmdʊt	jəmdʊt	death angel
sənyog	sənjog	coincidence
yʊktɪ	jʊktɪ	strategy (also a name)

It is observed that there is free variation between the /y/ and /j/ forms however, /j/ is more commonly attested in speech of speakers from countryside and the comparatively more educated speakers use more /y/ than /j/.

6.5. Occurrence of Gemination in Punjabi

Consider the examples below in comparison with their Sanskrit and Prakrit counterparts to understand occurrence of gemination in Punjabi.

Examples of Occurrence of Gemination			
Sanskrit	Prakrit	Punjabi	Gloss
sərpə	səppə	səpp	snake
kərɳə	kəṇṇə	kənn	ear
cərmən	cəmmə	cəmm	skin
əkʃi	əkkhi	əkk^{h}	eye
əgni	əggi	əgg	fire

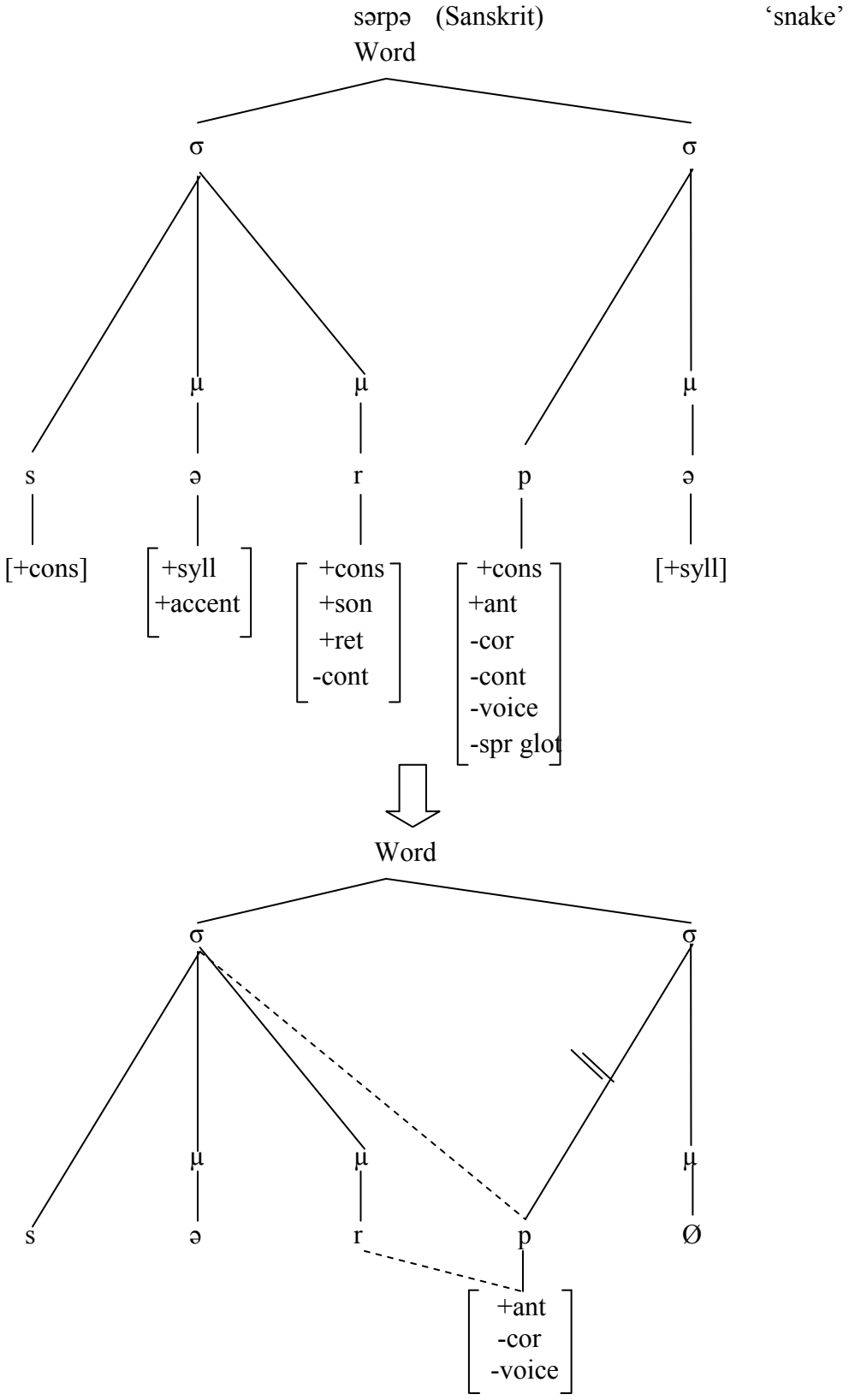
(Prakrit vocabulary has been taken from *A Comparative Dictionary of the Indo—Aryan Languages* by Turner)

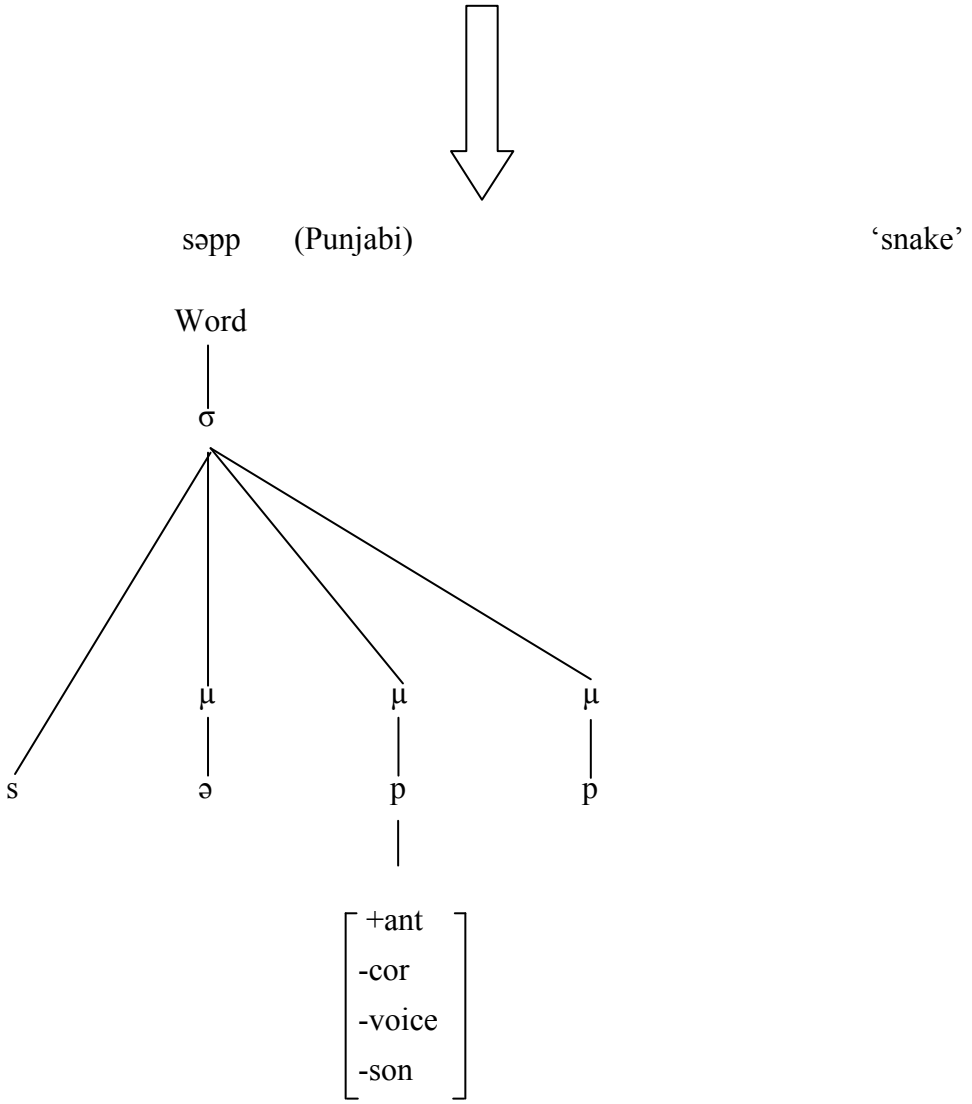
It is observed that the consonant cluster in Sanskrit is replaced by geminates in Prakrit and in Punjabi too. The first three examples are showing regressive assimilation, however the last two examples are showing progressive assimilation. The present work proposes that the direction of assimilation is not random and can be predicted. It is to be observed that the strength hierarchy is used in understanding which consonant will show gemination. The strength hierarchy given by Katamba (1989, p. 104) is given below in descending order. He also states that strength hierarchy is the inverse statement of sonority hierarchy.

Voiceless stops > Voiced stops > Voiceless affricates > Voiced Affricates > voiceless fricatives > Voiced fricatives > Voiced Approximants > Voiceless Approximants > Nasals > Liquids > Glides

The consonant which is stronger shows gemination. For example in [sərpə], /p/ shows gemination because it is stronger than /r/ according to the above mentioned strength hierarchy. Similarly, in [əkʃi], /k/ shows gemination as it is stronger than voiced sibilant.

Hence the direction of assimilation in geminates can be progressive or regressive, depending on the strengths of the two sound segments.





In the first step, rule of word-final schwa deletion applies due to which resyllabification takes place. In the second step, /r/ shows assimilation with voiceless bilabial sound /p/ as it is stronger.

6.6. Conclusion

The present chapter made an attempt to resolve two phonological problems in Punjabi by looking at it from a phono-morphological perspective, keeping the notion of syllable at the center and provided an adequate solution to them. The process of affixation changes the prosodic structure of the word thereby triggering the process of schwa deletion in Punjabi. The present work has shown that the problem of schwa deletion can be accounted for by taking into account accentuation. Schwa gets deleted on affixation if the syllable bearing accent precedes it and if the output of the rule doesn't violate phonotactic constraints of Punjabi. If the coda position of the accented

syllable is empty, onset of the syllable with schwa becomes coda of the preceding syllable. Also, it is proved that the schwa deletion rule applies before the rules of accentuation apply again to the word after resyllabification in Punjabi. Word-final schwa deletion rule is also stated, according to which word-final schwa present in Prakrit is deleted in Punjabi language.

There are three nasal segments and a nasal archisegment in the underlying forms in Punjabi. If the nasal archisegment is a part of accented syllable, it becomes a homorganic nasal and assimilates with respect to the place of the articulation with the following consonant. The nasal archisegment spreads its nasality to preceding vowel except in case of accented short vowel. The nasal archisegment gets deleted if it is part of the non-accented syllable.

Partial regressive assimilation takes place when morpheme is added to the word and there is a nasal consonant at the juncture. There is regressive assimilation of the place of articulation found in such words. Assimilation takes places in a word to reduce its complexity thereby making the articulation of the word easy. Therefore, by taking into account accentuation and by looking at the problems of schwa deletion and nasalization, many problems arising at the interface can be accounted for.

The present chapter has also accounted for the problems of glide insertion, /y/-/j/ alternation and gemination in Punjabi. Glide insertion rule states that glide is inserted whenever there is a vowel cluster in Punjabi. It is observed that /j/-/y/ are in free variation in Punjabi. With regards to gemination, it is observed that the short vowel followed by consonant cluster is replaced by a short vowel and geminates in Punjabi. Strength hierarchy is used to understand which consonant will show gemination.

DIFFERENT ASPECTS OF PUNJABI PHONOLOGY

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CHAPTER 7

CONCLUSION

The present work looked at the phonological problems of Punjabi from the point of view of prosody based non-linear generative phonology model and the syllable theory. This approach to the phonological problems of Punjabi is natural and explanatorily adequate. Keeping this in mind, some of the phonological processes of Punjabi were discussed in this work. The study made a contribution by keeping the notion of syllable and accent at the center.

The present work has made an effort to understand the phonological problems by supporting the analysis with acoustic findings, thereby revealing the acoustic correlates of the phonological concepts. It is observed that the notion of syllable is extremely significant to understand phonological problems in general. An attempt was made to keep syllable and accent at the center and in the context, the problems arising at the phonology-morphology interface have been dealt with. By doing so, the current work has made a three way bridge of bringing experimental phonology, theoretical phonology and phonological-morphological interface together in order to understand and explain the problems in phonology. A unique feature of the study is that it doesn't limit the scope to just accounting for one or two phonological problem(s) but attempts to look at more problems such as placement of accent, tones resulting from loss of aspiration, intonation, schwa deletion, nasal consonant formation and nasalization of vowels, glide insertion, alternation of high front glide /y/ with the back palatal voiced /j/, and occurrence of gemination.

The present study has collected and examined extensive data from the speakers of Punjabi and has provided an insight into the existing phonological problems. The study has examined the following phonological processes in Punjabi: accent, tones in relation to aspiration, intonation, schwa deletion, nasal consonant formation and nasalization of vowels, glide insertion, alternation of semi-vowel /y/ and palatal /j/, and occurrence of gemination. An importance of the present study lies in the fact that

the phonological processes are being supported by experimental work and this has led us to the claim that Punjabi has rising and falling tones and not high and low.

The first two chapters outlined the major motivation for the study and made an attempt to explain the problems. It also explained the approach employed for accounting for the above mentioned phonological problems. It briefly looked at the various available phonological theories and put forth the basic tenets for the present work. The first chapter is divided into five major sections. The first section has discussed the characteristics of Punjabi language that sets it apart from other Indo-Aryan languages and lists the linguistic differences in the different dialects of Indian Punjabi. Second section of the first chapter has briefly looked at the various available phonological theories and put forth the basic tenets for the present work. Third section has highlighted the phonological problems in Punjabi which were not fully resolved. It has been observed that the concept of syllable, by and large, had been neglected in the study of Punjabi phonology and the problems arising at the interface of phonology-morphology had not been looked into in detail from this perspective. Hence, the present work has bridged this gap by studying phonological problems in Punjabi by keeping the concept of syllable and accent at the center. Broad aims of the present work have been listed in the fourth section of the chapter and chapter division was discussed in the last section of the first chapter.

The second chapter is divided into two major sections. The first section has outlined the development of theory of syllable. The concept of syllable as defined by different phonologists has been looked at in detail. The understanding of Paṇini, Bloomfield (1933), Hockett (1955), Fudge (1969), Selkirk (1982), Clements and Keyser (1983), etc of the theory of syllable has been discussed in the chapter. The structure of a typical syllable and the multi-tiered phonological representation of a word from the word-tier to syllable tier to CV tier and segmental tier were shown in terms of a non-linear representation. The outlook adopted in the present work to account for the phonological problems in Punjabi has been discussed in the second section of the chapter. The representation of the prosodic features in the phonological representation was also shown in the chapter.

Chapter 4-6 surveyed the varied accounts available for explaining the existing problems in phonology of Punjabi. However, there has been a variation in opinions of different scholars, hence, the present work has made an attempt to resolve the phonological problems by looking at them afresh, with the help of acoustic data.

In the fourth chapter, accent in Punjabi has been studied by comparing vowels in different word positions and syllable weights with respect to duration, average f0 and maximum amplitude. To examine the acoustic realization of accent in Punjabi, an experiment was conducted comparing accented vs non-accented rhyme of the same weights with respect to duration, f0 and maximum amplitude. In order to control background factors, the number of each type of syllable (monosyllabic, bisyllabic and trisyllabic) was kept same in both groups. Also, the number of open syllables or syllables with sonorant or voiced stops in coda position was kept same. The findings of the experiment were helpful in determining the relation of the accent with- weight of syllable, and their position in a word. The rules of accentuation are given rationally by taking into consideration the morphological realities of the language, weight of syllable, and its position in a word. It is noted that the notion of extra-heavy syllables is very important in understanding the placement of accent in Punjabi. It is a very interesting accent pattern because of its multi-layered hierarchy of weight. The rules are also able to account for accentuation in words with affixes.

Rules of accentuation

a) All monosyllabic words are accented.

b) In bisyllabic words, the accent is on penultimate syllable. It shifts to ultimate only if the ultimate syllable is extra-heavy and penultimate isn't.

c) In trisyllabic words (and also in polysyllabic words), the accent is on penultimate syllable. It shifts to antepenultimate only if the penultimate is light and antepenultimate isn't or when the antepenultimate, penultimate and ultimate syllables are heavy.

d) The rules of accentuation apply again to the word after resyllabification.

Tones and intonation were studied in the fifth chapter. The present work focused only on understanding the relation between the orthographically present voiced aspirated sounds in words and the tones attested in spoken variety in Punjabi. The placement of tones is predictable in Punjabi. The placement and type of tones can be determined from the placement of accent and historically voiced aspirated sounds in the word. Tones have a synchronic relation with accent and a diachronic relation with voiced aspirated sounds, observed in its orthographic script. To have an empirical proof of the presence of tone and the rules of tone placement in Punjabi, an experiment comparing rising and falling tones was conducted. Rules of tone placement in Punjabi were given.

Rules of Tone Placement in Eastern Punjabi

a) All voiced aspirated consonants in orthography of Punjabi lose aspiration or a sound segment and tone is observed in the spoken variety. The tone rests on the accented syllable, therefore, every word has only one tone.

b) Falling tone is observed as a result of the rightward arising of the tone and rising tone is observed as a result of the leftward arising of the tone.

c) Devoicing will also take place iff the voiced aspirated sound is at the word-initial position.

The above rules make it possible to predict the exact location and nature of occurrence of tone. The present work has also proposed that Grassman's law applies before rules of tone placement. The present work has also replaced the terms 'high' and 'low' tones with 'rising' and 'falling' tones as pitch tracings resolve the same.

The present work verified and validated the findings of Singh (2006) by analyzing amplitude in place of the intensity cue. Also, the present work collected data from native speakers of Punjabi from Punjab. An experiment was conducted to study the various possible surface realizations (intonetic level) of sentences and the duration, f0, minimum amplitude, maximum amplitude and the difference in amplitude values of the constituents of various intonetic levels were studied to get the complete picture of

intonation pattern in Punjabi language. The various intonation patterns for Punjabi were shown and the comparisons between different horizontal and vertical level realizations were made using acoustic cues- duration, f0, minimum amplitude, maximum amplitude and the difference in amplitude values. It is claimed in the present study that amplitude is a strong cue for studying intonation patterns in Punjabi. It is observed that the same sentence can be spoken with different intonations in Punjabi which changes the acoustic measurements for the utterances. The intonations of several questions in Punjabi were studied using a sentence. The intonation of constituents with emphasis and with simple intonations was compared. Also, the intonation of different imperatives- order and request were compared with the intonation of a simple sentence. It is observed that the study of intonation could give us a lot of information about the prosody of Punjabi language.

The sixth chapter dealt with the phonological problems of schwa deletion and nasalization in Punjabi. It is argued that the problems may appear phonological in nature but these problems are emerging at the interface of phonology and morphology. Schwa deletion is found to be triggered by the process of affixation which changes the prosodic structure of the word. The problem of schwa deletion in Punjabi can be accounted for by taking into account accentuation and the concept of syllable. The order of rule application (reaccentuation rule and the schwa deletion rule) is also given in the work.

Rule of Schwa Deletion in Punjabi

a. Schwa gets deleted after affixation of a heavy syllable if schwa follows the syllable bearing accent. If the coda position of the accented syllable is empty, onset of the syllable with schwa becomes coda of the preceding syllable.

b. Schwa present in word final position in Prakrit is deleted in Punjabi language.

The present work identifies three nasal segments and a nasal archisegment has been proposed in the underlying forms in Punjabi. If the nasal archisegment is a part of accented syllable, it becomes a homorganic nasal and assimilates with respect to the

place of the articulation with the following consonant. The nasal archisegment spreads its nasality to preceding vowel except in case of accented short vowel. The nasal archisegment gets deleted if it is part of the non-accented syllable. Partial regressive assimilation takes place when morpheme is added to the word and there is a nasal consonant at the juncture. There is regressive assimilation of the place of articulation found in such words. Assimilation takes places in a word to reduce its complexity thereby making the articulation of the word easy. The assimilation follows the strength hierarchy according to which oral vowels assimilate with the following nasal consonant as nasals are stronger.

Rule of Nasalization of Vowels: Nasal archisegment assimilates with the following consonant and spreads it nasality to preceding vowel except in case of accented short vowel. Nasal archisegment gets deleted after spreading its nasality to short non-accented vowel.

The present chapter has also accounted for the problems of glide insertion, /y/-/j/ alternation, and gemination in Punjabi. Glide insertion rule states that glide is inserted due to morphological processes at the interface of phonology and morphology..

Glide Insertion Rule: There is insertion of glide at the phonology-morphology interface between two vowels coming together due to morphological processes.

It is observed that the high front glide /y/ with the back palatal voiced /j/ are in free variation in Punjabi and with regards to gemination, it is observed that the short vowel followed by consonant cluster is replaced by a short vowel and geminates in Punjabi. Strength hierarchy is able to explain which consonant fully assimilates another.

The present work has applied a scientific theory which is explanatorily adequate and is based on the deductive approach to the understanding of phonological processes in Punjabi. The present work was developed an approach to look at the phonological problems in Punjabi based on earlier works to look at the problems in the phonology of Punjabi. The following works deserve a special mention here: Gargesh's (1999) work on tones in Punjabi, Singh's (2006) work on intonation of Punjabi and Sethi's

(1997) work for developing a phonology-morphology interface model. The present work must therefore be considered as a continuation and a development in relation to the available work on the literature of Punjabi language.

It is hoped that the findings of the present study would have bridged the gaps in existing literature and answered many unresolved problems in Punjabi phonology. It is hoped that the present work will encourage scholars and researchers to look at the phonological problems of Punjabi in terms of phonology-morphology interface with experimental data to support their analyses.